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Leaching Mixed Oxide and Sulphide Copper Ores at Inspiration

By Harold W. Aldrich and Walter G. Scott

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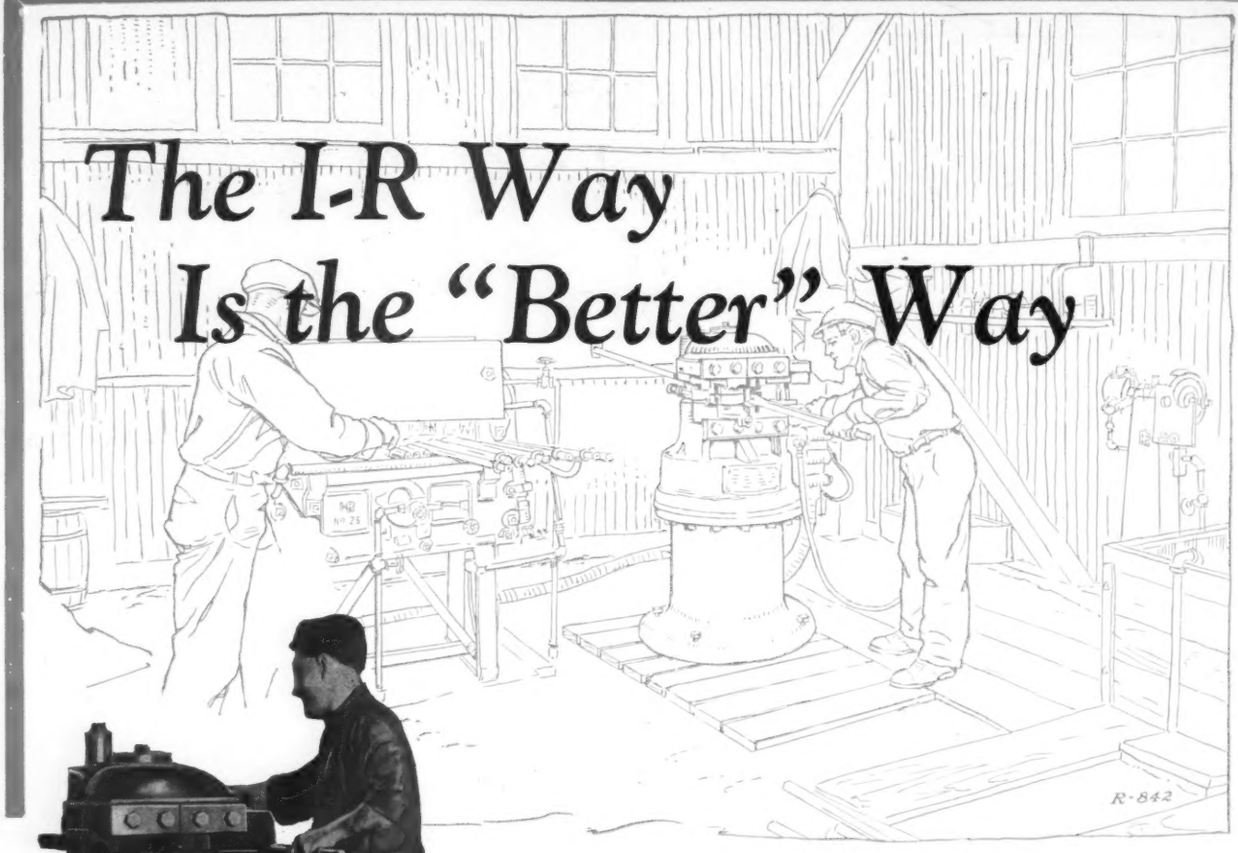

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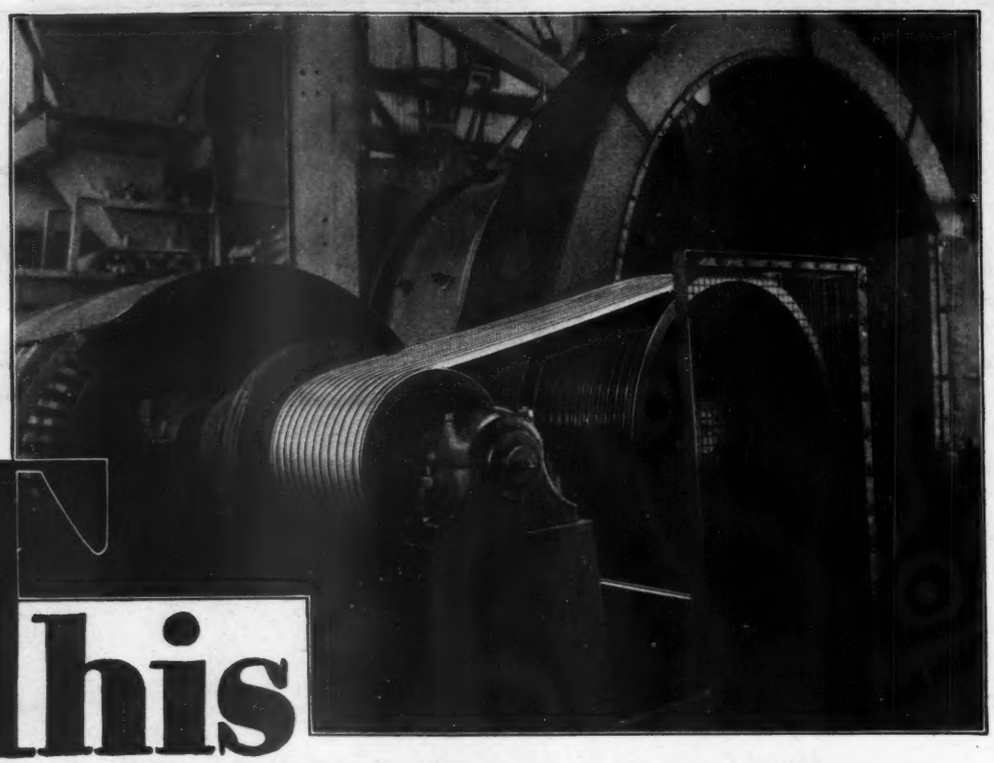

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ENGINEERING AND
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Noise—An Undetermined Factor in Industrial Accidents

NOISE and noise abatement, as subjects of almost popular discussion, are attracting an unusual measure of attention. Most of this consideration has been occasioned by general living conditions in the larger cities. In New York, for instance, a committee of eleven men—authorities in the fields of neurology, otology, engineering, law—has just been appointed by the municipal commissioner of health to solve what is termed "this growing problem of metropolitan life." The problem, however, would appear to be complex, for much of the evidence obtained from investigations already made in this field indicates that the effect of various noises on the individual is not clearly understood. This fact, with numerous examples in substantiation, is discussed in the current issue of *Harpers Magazine* by Mr. H. M. Johnson, of the Mellon Institute of Industrial Research, in his article "Noise: A Social Problem," wherein he points out that it is virtually impossible to produce scientific proof that particular noises are injurious.

The conclusion might plausibly be held by many that in most industries the more important effects of noise on employees could be ascertained readily. But, here again, the subject was found to be beclouded by a lack of fundamental knowledge. Recognition of this general situation was early expressed by the National Safety Council's research committee on noise and its relation to accidents, which three years ago came to the conclusion that its chief opportunity for service was in endeavoring to interest competent scientists in investigating the real effects of noise on the human body. In the committee's most recent report, made two weeks ago at the Annual Safety Congress held in Chicago, a continuation of this program was recommended. Some progress has been made. Fundamental data have been developed, and announcement was made that a direct study of the relation of noise to accidents appears to be possible at present in connection with one of the known effects of noise on human being—the masking effect in audition, or temporary deafness induced by noise.

Pending the development of further definite knowledge by scientific investigators, the various industries must continue in almost complete ignorance of the effect of noise on workers. Few mining men, however, will question the supposition that noise is a contributing factor to accidents, and some, perhaps, are willing to admit a belief that certain noises influence detrimentally the health of employees. In underground operations, the noise of rock drills and other mechanical devices may prevent a worker from recognizing the hazard of "talking ground," or of hearing the verbal warnings of impending danger given by fellow workers. Certainly, under such circumstances, noise might well be an indirect cause of an accident. Also, if the actual explosion of shells, as opposed to fear, affected seriously the well-being of certain individuals during the World War, might not workers of similar constitution experience detrimental physical reactions from being subjected regularly to the noise and concussion of blasting?

The answers to this question and to many others of a similar character are important, not only if industry is to be conducted as efficiently as possible but also if the health and social life of present-day civilization are to be safeguarded properly. Again, the world must look to scientific research for guidance.

Conventions as They Seem to Some

CONFLICTING views on the purpose and value of conventions are expressed by spokesmen for two different business firms, writing in their respective "house organs." "Aren't they queer?" says one, a publisher of scientific books. He cites statistics: 15,000 conventions annually, attended by three million individuals who spend $75 each. This he considers offers a fascinating field for research. Conventions, he declares, serve no really utilitarian purpose and are regarded as a bore by many. Clearly bosh, he thinks, is the statement that the desire to exchange ideas is the drawing card. "Any idea worth getting is pretty certain to be committed to print. One does not, in these literate days, need to go from hither to thither in person to procure an important idea." A more likely reason, this writer asserts, is the desire to "rub elbows," to build up an acquaintance, or simply to put in an appearance because others identified with the profession or industry are present.

In contrast are the words of the second spokesman, who represents an important manufacturer, in speaking of a recent meeting: "To a few, perhaps, it was just another convention, a place to renew old acquaintances, to do a little playing. To the majority, however, it was a splendid opportunity to create and develop new ideas and new methods, a place of inspiration for the progress that must go on and the work that must be done. For many the lack of the usual business cares sets up an ideal condition, conducive to a type of thinking bound to bring results."

Conventions are never stupid, though individual sessions may be dry as dust. Truly boresome are some moments—as during the monotonous droning of the gen-

tleman who will read his paper though the heavens fall, despite the fact that every one before him has a copy of it in his hand; or when the invitation to discuss a paper elicits no response. Programs can be improved, indeed. The remedy often lies in the proper choice of chairmen. A lively presiding officer can do much to promote discussion among the members present, with resultant rapid fire of ideas.

The principal value of conventions lies in the opportunity they afford to get together—to "rub elbows," as the first-mentioned spokesman puts it. One such meeting can do more than months of correspondence. Inspiration is found in numbers, and action can more readily be secured.

A weakness for conventions may indeed characterize the occupants of the "great American bandwagon." But is it not an outgrowth of the intensity of industrial life? Exchange of ideas by means of the written word is slow at best. Energetic business and professional men must get together to talk things over.

A Good Idea to Insure Staff Co-operation

IN RECENT issues of *E.&M.J.* appeared papers by two Phelps Dodge engineers, Mr. W. I. Nelson and Mr. Charles W. Tully, on mining and concentration methods at Bisbee. The method of presentation is worthy of comment. Primarily they were prepared for reading at a staff dinner, so that other members of the organization not intimately connected with the caving work at the mine, or the selective flotation process applied at the concentrator, might know of the difficulties encountered and how the problems were being solved. For example, if the mill superintendent one day should find a pronounced change in the character of his ore he might guess the reason; and, on the other hand, the mine superintendent would understand better the importance of maintaining a constant grade of ore. But the authors of these papers were sufficiently careful to make their efforts worthy of a wider audience. Therefore, the local newspaper will republish them, so that all those working for neighboring companies will have the opportunity to read them; and *Engineering and Mining Journal* was also privileged to pass the information along to those in charge of similar work all over the world.

The advisability of having occasional staff dinners is first to be emphasized. The benefits, social and technical, are not realized by many large companies. Where the mine, mill, smelter, or refinery adjoin, more or less understanding of the work is usually possible, as are friendships among the personnel of the individual units; but where operations are conducted in separate camps, social and technical communion is usually confined to officials with general supervisory duties; a foreman in a mill or smelter may never have been underground in the mine ten miles away. The staff dinner idea of the Phelps Dodge Corporation, with the opportunities which it presents, is therefore an excellent one.

Presentation of one or more well-prepared papers at such a staff dinner is also to be commended highly. Preparation of such papers affords excellent practice for the junior members of the staff in clarifying their thoughts and making written reports of their work. The reading of such papers gives the engineer much-needed practice in public speaking, and the ensuing discussion may well develop ideas of value to the company. Later, the journal of the industry carries the report to the outside world, which insures maximum credit, to the author and to the organization with which he is connected, for work well done.

Engineering and Mining Journal suggests the further extension of this most excellent practice, and is prepared to give wide publicity to papers like Mr. Nelson's and Mr. Tully's. Such papers, though they may be prepared in the first instance for local information, are deserving of a wider circulation.

The Canadian Investing Public and Elementary Newtonian Physics

"WHAT GOES UP must come down" is the layman's way of expressing Sir Isaac Newton's conception of the laws of gravity. In common with many other household proverbs, however, the layman does not always remember it. The present sad state of affairs on the Canadian mining exchanges is an example of his forgetfulness. A decline in the valuation of Hollinger started nervous sympathetic oscillations in other "gilt-edged" stocks about a year and a half ago. These continued until three or four weeks ago, when, International Nickel excepted, almost every important Canadian mining stock broke sharply. No signs of recovery have yet been shown. The public, dearly beloved of all financial writers, has been losing money in mining stocks, a situation that calls for remedial action. Foremost in the ranks of would-be reformers are the purveyors of "dope" on mining stocks, who are always ready to point out the silver lining no matter how dark the cloud may seem. In the *Mail and Empire,* of Toronto, an article was recently published on the subject of mine managers and their obtuseness in not providing sufficient favorable publicity material of news value to keep mining stocks constantly on the upgrade.

"The Street theory is that if the mine managements came out regularly with statements of facts and figures, the public could do its own judging and would not have to depend on rumors and brokers' wires from the scenes of operations," the writer declares. "The further theory is that if the shareholders had the actual facts at frequent intervals they could not be stampeded by such market manipulations as have recently been witnessed, and the Canadian mining industry would escape the black eye which it seems almost certain to acquire under existing conditions."

The proud papa of this interesting effusion is evidently one of those "economists" who labor under the delusion that industry revolves around and for the special benefit of the stock market. The mine manager, on the other hand, may feel that no valid justification exists, from the standpoint of social utility, for transactions whereby Mr. X buys ten shares of Consolidated Silver-Gold on one

day and sells them the next for a small profit. After all, he is not furthering industry thereby. To the mine operator, the real capitalist is the man who risks his money by buying stock when the company is formed, and who remains a shareholder for a reasonable length of time. Of such men the mining industry asks support. But it cannot be held responsible for the losses of those whose ideas of investment appear to many as inferring that it is synonymous with gambling. Nor should the mining industry be asked to further speculation by regularly issuing pabulum about possibilities and perhapses and maybes.

No more staunch advocate of the gospel of publicity for mining operations can be found than this publication, as instanced by the Phelps Dodge and Anaconda issues. But for a mining company to put "actual facts" before the public is no guarantee that these facts will not be exaggerated. The public's "judging," of which the *Mail and Empire* speaks, is not likely to be dispassionate.

Within the last four or five years our neighbors to the north have become aware of the tremendous rewards that mining offers to the fortunate investor; they have realized the potentialities of their country; they have thoroughly overemphasized those potentialities (a failing by no means limited to Canadians); and, now that their expectations are not being fulfilled, they are complaining. Increasing prices cannot continue forever. The turn downward apparently is now under way. But no more reason exists for holding the mine managers responsible than for blaming the ovine speculators, if indeed as much.

The financial writers should have pointed out the lack of official news when prices were ascending, not when they started to fall.

What Price Diamonds?

IN THE current issue of that well known McGraw-Hill annual, *The Mineral Industry*, Dr. G. F. Kunz, writing on the subject of "Precious and Semi-precious Stones," refers to sensational newspaper publicity concerning the heavy production of diamonds, and the tendency to lower prices, in spite of which, he maintains, prices have remained almost constant. Decreases that have occurred were mostly confined to the small low-grade stones that have made up the bulk of the heavy increase in production during the past few years. The demand for high-grade stones is even better than ever before, and prices have actually advanced.

Much has been said about the harmful effect on the market of the recent discoveries in Namaqualand, Doctor Kunz reminds us, but, as a matter of fact, the discovery of these deposits has been a benefit to the market rather than a disadvantage. This territory has made available a supply of high-grade stones such as never before was known, which, under careful control as to distribution, has served to satisfy a demand that has for several years past been under-supplied. If this territory had been exploited in the same uncontrolled fashion in which the Lichtenburg diggings were opened up two years before, the results would have been disturbing. But under strict control, and with the stones in the hands of the government, with their disposal rationed as the market could absorb them, the results have been highly satisfactory.

Dissemination of Scientific Knowledge Is a Duty of Technicians

IN A recent issue of *Engineering and Mining Journal* two pages were devoted to illustrations showing applications of mining and metallurgical equipment in other industries. Although the eight views published covered a wide range of various types of mechanical devices, they were merely representative of numerous similar installations that have been made outside the mining industry. Space limitations precluded the possibility of pictorially telling a complete story. The two pages, nevertheless, will be informative to many, for detailed knowledge of the methods and mechanical aids employed in any one field is usually confined to those comprising its personnel. The few exceptions to this generalization have been significant and indicative of latent opportunities. For example, the borrowing of an equipment idea invented by an engineer in the non-ferrous mining industry has necessitated the use of one of the metal products of that industry. In this instance a classifier constructed of copper was adopted by a manufacturer of storage batteries to wash nickel hydrate flakes free from soluble salts. Contamination of the classifier product with attrited iron was thus avoided, as well as possible corrosion of the equipment itself.

Lack of a broad knowledge among technicians is to be regretted, because many operating economies might otherwise be effected. The situation, however, is a general one that has largely been inevitable, owing to the rapid strides made in scientific achievement. Comparatively few people have even a slight understanding of the technical principles involved in the numerous devices that science has placed at their disposal. This condition is becoming increasingly evident, and has reached a degree that prompts popular satisfaction in such ignorance. One large mercantile firm, for example, which sells radios to the retail trade, advertised recently in the metropolitan daily press to the effect that "If you are one of the many who know nothing about radio, this is the place to buy your set—our goods are dependable." The scientific principles governing the operation of a radio set are not understood by most users, but that this ignorance has advertising value is somewhat extraordinary, besides being indicative of the appraisement that the general population places on its own lack of technical understanding.

Education is the only solution to the problem, as pointed out in a recent address by Dr. Walter T. Marvin, dean of the college of arts and sciences of Rutgers University, who contends that, if democracy is to be saved, the ordinary man must be taught at least the elements of those sciences that are transforming the world about him. Technicians can aid materially in such a campaign by encouraging and fostering a dissemination of their knowledge in a form readily understood by the layman. The situation, moreover, affords scientists, educational institutions, and the technical press an opportunity to render a real service to humanity. *Engineering and Mining Journal*, and the other McGraw-Hill publications, are well aware of this and are constantly supplying to many agencies the type of article that has educational and informative value for the average reader. Technicians in the mining industry should assist in the solution of this problem, for it imposes an obvious duty on all those possessed of scientific knowledge and the ability to apply it for the benefit of industry and society.

Leaching Mixed Oxide and Sulphide Copper at Inspiration

• FROM *Jan. 15, 1929, to the present time, the primary fines from all ore to be leached at the Inspiration plant have been removed by classification, the sand being delivered to the leaching tanks and the overflow being sent to storage ponds. Plans are completed and construction has started on the installation of a slime-leaching plant.*

In the second installment of this article is a discussion of the improvement in leaching results effected by the classification of the primary fines, as well as the proposed flow sheet and the estimated results from the slime-leaching plant.

HAROLD W. ALDRICH

and

WALTER G. SCOTT

Respectively, Superintendent and Assistant Superintendent, leaching plant, Inspiration Consolidated Copper Company, Inspiration, Ariz.

IN THE FALL of 1918, experimental work was started on the development of a process to treat the oxide and the mixed oxide and sulphide ore of the Live Oak and Keystone sections of the Inspiration mine, at Inspiration, Ariz. Prior to this the concentrator had been treating the sulphide ore from the Inspiration division, but the mixed ore in the Live Oak and Keystone sections carried too large a proportion of its copper in the form of chrysocolla for satisfactory flotation treatment. Consequently, the operators realized that a method must be developed to recover this oxidized copper in the mixed ore.

The first experiments were made on what was styled the "Dual Process." This consisted of a pre-leach with sulphuric acid to recover the oxidized copper, followed by fine grinding and flotation of the leaching plant tailing to recover the copper present as sulphide. These experiments continued until October, 1922. The first work was done in a laboratory test plant shown in an illustration on page 615. Provision was made for counter-current leaching on 10-lb. lots of ore and electrolytic precipitation of the copper in the leach liquor. The solution was moved from one jar to another by small air lifts, and every effort was made to approach, as closely as possible, actual operating conditions.

Results from this laboratory plant warranted a larger unit, so a 35-ton-per-day pilot plant was constructed. In this were seven concrete, lead-lined leaching tanks 5x10 ft. in section and 16 ft. deep, each having a capacity of 35 tons. Lead-lined concrete tanks for the various wash waters were provided, as well as a complete electrolytic precipitation plant.

A total of 6,970 tons of ore was treated during the experimental work on the "Dual Process," and results were very encouraging.

At this time Dr. Ricketts engaged Mr. G. D. Van Arsdale, a consulting metallurgist, of Los Angeles, to conduct some small-scale experiments on the hydrometallurgical treatment of flotation concentrate, using ferric sulphate in solution as a solvent for the copper sulphide. The results from this work were encouraging enough to bring up the feasibility of the treatment of the Inspiration mixed ores by a solution containing sulphuric acid and a sufficient percentage of ferric sulphate so that both sulphide and oxide copper could be dissolved in one operation, thus eliminating the flotation of leached tailing.

The 35-ton pilot plant was again put in operation, testing out Mr. Van Arsdale's plan of a sulphide leach by means of ferric sulphate. It ran continuously from February, 1923, to December, 1923, when the operators decided that the results obtained insured the success of the process. During this test period, 2,782 tons of ore was treated.

Metallurgically, the results from the "Dual Process" experiment were about as good as those from the ferric sulphate leaching, but the production cost estimates favored the ferric sulphate leach. From the results of this experimental run, an estimate was made in 1925 that an ore carrying 1.19 per cent copper, of which 0.77 per cent was as oxide and 0.42 per cent as sulphide (estimated from drill-hole results), could be leached to give a a tailing carrying 0.182 per cent total copper and a total extraction of 84.7 per cent. (Compare the actual results for 1927, which show a feed of 1.056 per cent total copper and a tailing carrying 0.188 per cent total copper. During the last six months of the year, after operations were smoothed out, the tailing averaged 0.161 per cent total copper on a feed carrying 1.034 per cent copper, giving an extraction of 84.43 per cent.)

In September, 1924, excavation was started for the construction of a plant to treat 7,500 tons of ore per day,

which plant was put into operation in October, 1926. Upon starting the plant the fact developed that by a minor change in the height of the overflow on the leaching tanks, 9,000 tons could be charged into them and treated satisfactorily. This determined the maximum capacity of the plant as 9,000 tons per day.

Roll Crushing Prepares Ore for Leaching

The ore as received from the mine is delivered to the same coarse-crushing plant as that used to crush the sulphide ore for the concentrator. It consists of gyratory crushers and horizontal shaft Symons disk crushers, which reduce the ore from mine run to 1½ in. Mixed ores are delivered by belt conveyor from the coarse crusher to the mixed-ore bins at the leaching plant. The capacity of these bins is about 10,000 tons, of which 8,000 tons are available. Then the ore is drawn to a conveyor and thence to a bank of eight Hum-mer electric vibrating screens. The screen opening has varied from ½x⅞ in. to ¼x½ in., depending upon the change in physical character of the ore. Undersize goes direct to the leaching tanks and oversize to a pocket bin over the set of rolls which is then operating as a coarse roll.

The four sets of 78x24-in.-face Traylor rolls have 9-in. shells. Two sets are operated as fine rolls and one set is operated as a coarse roll, leaving one as a spare. The discharge from all rolls is delivered to sixteen Hummer screens equipped with ⅜-in. ton-cap screen cloths. Undersize from these goes direct to the leaching tanks and oversize returns to pocket bins over the two fine rolls. The coarse rolls are set at ⅝ in. and the fine at $\frac{5}{16}$ in. The rolls operate at 110 r.p.m., and each set uses 275 hp. Each roll of a set is separately driven by a 225-hp. motor, using a Lenix drive. The large motors were in stock when the plant was built, and they are of sufficient capacity to start the rolls without the use of the crane. The shells are all put on cold and tightened by movable centers or wedge rings. Each shell lasts approximately 1,600 hours of operation, giving a steel consumption cost of $0.0076 per ton of total ore crushed.

In the operation of all crushing and conveying machinery the drives are interlocked electrically, so that

Screen Analyses, Showing Reduction of Ore in Fine-Crushing Plant

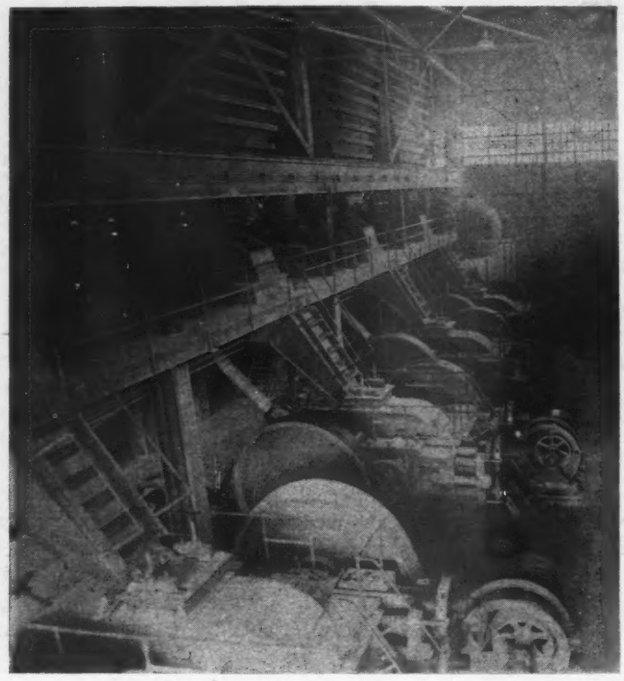
Mesh In.	Feed to Leaching Tank	Ore from Coarse-Crushing Plant	Oversize from Primary Screens to Coarse Roll	Roll Product Conveyor	Oversize from Secondary Screens to Fine Rolls	Undersize from Primary Screens to Leaching Tanks	Undersize from Secondary Screens to Leaching Tanks
		No. 3	No. 4	No. 6	No. 5	No. 7	
+2	.....	0.0	0.0	....	....	....	....
1½	.....	2.1	17.9	....	....	....	....
1	.....	17.8	39.5	....	....	....	....
¾	.....	11.4	17.6	4.7	14.2	....	....
½	.....	8.3	10.9	10.7	24.5	....	....
⅜	.....	6.3	5.3	14.8	22.5	....	....
3	19.88	7.1	3.8	29.2	30.7	20.8	19.3
4	15.65	5.6	1.1	13.1	4.0	12.3	17.4
6	10.95	5.2	0.4	7.3	0.8	8.0	12.5
8	8.02	4.4	0.2	4.6	0.4	7.6	8.5
10	7.16	4.3	0.2	3.4	0.2	7.0	7.0
14	5.47	3.5	0.1	2.2	0.2	5.5	5.5
20	4.26	2.7	0.1	1.4	0.1	4.5	4.1
28	3.74	2.4	0.1	1.0	0.1	4.1	3.5
35	3.23	2.2	0.1	1.0	0.1	3.8	3.0
48	2.63	1.8	0.2	0.7	0.1	3.0	2.4
65	2.80	2.0	0.3	0.7	0.1	3.3	2.5
100	1.50	1.1	0.2	0.4	0.1	1.8	1.3
150	1.35	1.0	0.2	0.5	0.1	1.5	1.3
200	1.18	0.6	0.2	0.3	0.1	1.3	1.1
200	12.18	10.2	1.6	4.0	1.7	15.5	10.6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Leaching plant, and in the foreground the mine surface plant, as seen from the air

whenever a motor driving a conveyor kicks out, all machinery delivering ore back of it immediately stops.

Crushing of 9,000 tons requires about ten hours, the schedule for crushing being arranged so as to permit most of the day shift being used for repairs.

The conveyor delivering crushed ore to the tanks is equipped with a weightometer. A bucket sampler cuts



Bins and roll crushers in the fine-crushing plant

the discharge stream on the same belt, so that an accurate weight and an accurate sample of the ore in each charge are obtained. One conveyor travels the whole length of the bank of leaching tanks, a distance of 1,000 ft.

Summary of Leaching Process

The thirteen concrete, lead-lined, leaching tanks are each 175 ft. long, 67.5 ft. wide, and 18 ft. deep, and have a capacity of 9,000 dry tons of ore per tank. They are lined with 7-lb. chemical lead. On the side walls the lead is protected by a covering of 2-in. planks held in place by vertical posts. The filter boards are of 2-in. material having fifteen $\frac{3}{8}$-in. holes per square foot of

Inspiration Consolidated Metallurgical Results for the Last Three Years

	1927	1928	First Six Months, 1929
Feed			
Ore charged, tons	3,099,639	3,182,546	1,771,758
Per cent moisture	4.666	4.423	7.592
Ore charged, tons dry	2,955,014	3,041,334	1,637,246
Per cent oxide copper	0.718	0.632	0.679
Per cent sulphide copper	0.338	0.387	0.483
Per cent total copper	1.056	1.019	1.162
Per cent ore on 4 mesh	41.5	37.2	20.0
Per cent ore through 20 mesh	25.3	30.7	30.9
Tailing Excavated			
Per cent moisture	11.647	11.695	10.685
Per cent oxide copper, acid soluble	0.048	0.053	0.025
Per cent oxide copper, water soluble	0.011	0.012	0.002
Per cent sulphide copper	0.129	0.135	0.106
Per cent total copper	0.188	0.200	0.133
Per cent oxide copper extraction	91.783	89.715	96.024
Per cent sulphide copper extraction	61.834	65.116	78.054
Per cent total copper extraction	82.197	80.373	88.554
Lb. of copper dissolved per ton of ore	17.36	16.38	20.58
Solutions			
Gal. per minute acid solution advance	1,427.6	1,761.5	1,962.9
Total gallons acid solution advance	750,367,000	928,367,456	511,622,000
G.p.m. copper solution to tank house	1,570.5	1,836.0	1,920.2
Total gal. copper solution to tank house	825,470,000	967,646,608	500,482,000
Sp. gr. of solution to tank house	1.192	1.165	1.169
Grams per liter—			
copper in solution to tank house	28.2	23.4	25.8
copper in solution from tank house	22.3	18.2	20.7
acid in solution to tank house	41.4	30.6	26.6
acid in solution from tank house	56.6	45.0	44.5
total iron in solution to tank house	17.3	16.0	19.0
ferric iron in solution to tank house	5.9	5.3	4.6
ferric iron in solution from tank house	10.2	9.3	10.0
Solution temp. to tank house, deg. C.	32.4	31.8	33.6
Solution temp. from tank house, deg. C.	42.2	40.0	42.5
Solution temp. from heating plant, deg. C.	50.2	47.6	45.2
Atmospheric temp. deg. C.	17.7	18.7	17.0
Gallons of oil burned	881,490	1,107,172	496,260
Tank House: Commercial Division			
Total weight of commercial copper pulled	47,833,425	42,707,143	26,565,193
Total weight of cathodes pulled	54,404,845	49,399,338	31,036,811
Average weight of cathodes pulled	100.4	91.6	84.9
Average voltage between anodes and cathodes	2.36	2.24	2.37
Average current density	14.2	11.8	15.7
Number of tanks on cathodes	117.2	120.0	120.0
Tank House: Starting-Sheet Division			
Number of tanks on starting sheets	13.0	14.7	15.1
Number of starting sheets made	662,542	647,311	423,780
Average weight of starting sheets	10.6	11.3	11.3
Lb. soluble anodes received	10,015,240	10,298,480	6,836,340
Lb. anode scrap shipped	2,234,520	2,442,540	1,732,640
General			
Lb. electrolytic copper shipped	55,632,371	50,588,749	31,623,954
Gross a.c. kw.-hr. to sub station	78,972,009	65,757,166	45,731,074
Gross d.c. kw.-hr. to tank house	72,305,451	59,407,654	40,733,506
Per cent conversion efficiency	92.1	92.0	92.0
A.c. per pound of copper kw.-hr.	1.641	1.540	1.718
Average ampere efficiency on produced copper	61.43	64.66	60.98
Lb. 60 deg. Bé. acid per ton of ore	31.36	26.5	33.0
Gal. of new water used for washing	71,953,300	73,246,920	19,867,850
Lb. copper as cement copper shipped	4,079,508	7,321,914	6,708,077
Lb. copper as copper slime shipped	100,919	210,044	84,221

Screen Analysis, Feed, July to December, 1927, Inclusive

Mesh	+3	+4	+6	+8	+10	+14	+20	+28	+35	+47	+65	+100	+150	+200	—200
July	22.80	16.51	11.19	7.58	6.65	4.96	3.87	3.35	2.88	2.34	2.48	1.37	1.29	.94	11.80
August	16.07	15.12	11.54	8.28	7.49	5.73	4.61	4.05	3.53	2.84	3.08	1.62	1.46	1.11	13.44
September	18.99	15.78	11.05	7.86	7.10	5.42	4.31	3.78	3.32	2.65	2.89	1.60	1.34	1.32	12.57
October	19.45	15.29	10.77	7.97	7.45	5.69	4.38	3.87	3.31	2.66	2.89	1.53	1.31	1.26	12.20
November	21.73	15.47	10.42	7.96	7.05	5.36	4.16	3.70	3.19	2.61	2.73	1.44	1.35	1.22	11.60
December	20.25	15.73	10.73	8.42	7.21	5.69	4.23	3.71	3.17	2.69	2.74	1.46	1.37	1.24	11.46
Average	19.88	15.65	10.95	8.02	7.15	5.47	4.26	3.74	3.23	2.63	2.80	1.50	1.35	1.18	12.18

Assays of Screen Sizes, Feed, July to December, 1927, Inclusive

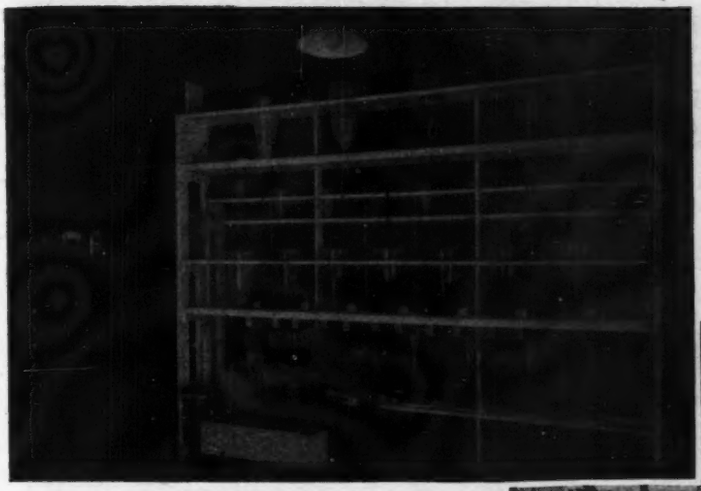
Total copper	0.819	0.809	0.848	0.874	0.903	0.945	1.008	1.093	1.202	1.322	1.496	1.608	1.646	1.648	1.493
Oxide copper	0.485	0.485	0.493	0.526	0.543	0.583	0.615	0.656	0.696	0.745	0.802	0.868	0.879	0.902	1.091
Sulphide copper	0.334	0.324	0.355	0.348	0.360	0.362	0.393	0.437	0.506	0.577	0.694	0.740	0.767	0.746	0.402

Assays of Screen Sizes, Tailing, July to December, 1927, Inclusive

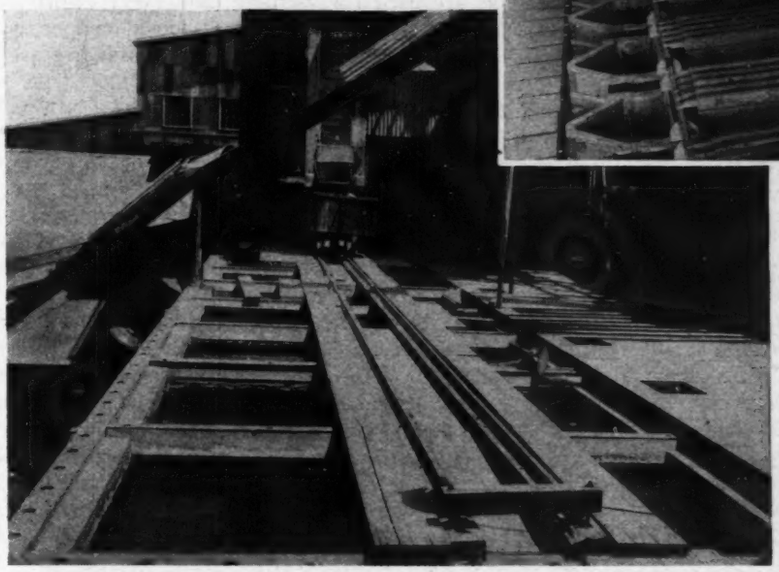
Total copper	0.216	0.172	0.130	0.120	0.115	0.101	0.103	0.110	0.119	0.135	0.171	0.202	0.224	0.251	0.328
Oxide copper	0.075	0.049	0.029	0.013	0.003	0.002	0.002	0.002	0.002	0.000	0.000	0.000	0.000	0.018	0.156
Sulphide copper	0.141	0.123	0.101	0.107	0.112	0.099	0.101	0.108	0.117	0.135	0.171	0.202	0.224	0.233	0.172

	Total Copper	Oxide Copper	Sulphide Copper
Calculated average feed assay (a)	1.015	0.622	0.393
Actual average feed assay	1.015	0.622	0.393
Calculated average tailing assay (a)	0.199	0.054	0.145
Actual average tailing assay	0.208	0.068	0.140

(a) Calculated from assays and screen sizes.



In the illustration above is shown the laboratory leaching plant. To the right are the electrolytic cells of the 35-ton pilot plant, and below is a view of the pilot plant leaching tanks.



surface, countersunk with a ¾-in. hole from beneath. The tank bottom slopes slightly toward the center as well as toward the end where the drain pipe is situated. There is but one opening in the bottom of each tank, a 14-in. lead pipe burned to the lead lining, entering at the opposite end from the overflow, just above the tank bottom and below the filter bottom. All solution entering the tank does so at this point and all drainage is taken out here.

In charging, the ore is distributed equally over the entire tank. A movable spreading machine spans the bank of tanks and is equipped to travel from one to another. A tripper discharges the ore from the conveyor which travels the length of the bank of leaching tanks on to a belt traveling the length of the spreader. An automatically reversing tripper travels on the spreader and empties the load of the spreader belt into the tank. At each reversal of this tripper the spreader bridge moves forward 2½ ft., until it reaches the edge of the tank, when the motion is reversed and the bridge travels toward the opposite edge. In this way the tank is filled with ore evenly over its entire area. The ore bed rises about 3 ft. for each pass of the bridge over the tank. In bedding in this manner practically no rolling or segregation of the material in the charge takes place.

The ore, after bedding, is first covered with a solution strong enough in acid to avoid neutrality at any point within the charge; otherwise a decided loss in iron content would occur through the precipitation of iron salts. A high copper content of the tailing usually accompanies this precipitated iron. Percolation of solutions is upward. Each tank is provided with a vertical screw type lead pump which receives the overflow solution from the preceding tank and pumps it underneath the filter bottom and up through the ore. The solution overflows into a launder and goes to the suction of the pump serving the next tank, which permits the tanks under acid treatment to be in series. The circulation on each tank is approximately 1,500 g.p.m.

The complete cycle is thirteen days, as one tank is excavated and one filled each day. Eight tanks are under acid contact at all times, three are being washed, one tank is being filled, and one being excavated. The strong acid solution from the tank house, in which sulphuric acid and ferric sulphate have been regenerated and to which the required amount of new acid has been added, is delivered to the oldest ore under acid contact. This solution travels from tank to tank, constantly being reduced in solvent strength and increased in copper content, until it emerges from the newest ore, after which it flows back to the tank house.

The principal difference in operation between the Inspiration plant and other large leaching plants is that at Inspiration a deliberate effort is made to maintain the ferric sulphate concentration at a point high enough to dissolve the large amounts of copper contained in the ore as chalcocite. This necessitates carrying a high percentage of total iron in solution, even though a high concentration of ferric sulphate is a decided detriment to electrolytic precipitation efficiency.

Manipulation of solution and solution strengths to preserve an economic balance between the necessary strength of ferric sulphate for sulphide extraction, and avoidance of the penalty incurred by iron in electrolytic precipitation efficiency, presents a delicate point in operation which has been entirely worked out. As the ore is constantly changing in grade, particularly the relation of sulphide copper to oxide copper, the economic limit of solvent strengths must also change. General practice has been to attempt to hold the average strength of ferric sulphate during the leaching of any ore charge at 7.5 grams per liter, with the maximum strength between 10.0 and 10.5 grams per liter and the minimum strength between 5.0 and 6.0 grams per liter. The consumption of ferric sulphate is approximately the theoretical amount required for dissolving the sulphide copper.

Factors Affecting Acid Consumption

Acid concentration has always been held higher than necessary for the extraction of the soluble copper. Experimental work demonstrated the fact that even though the solution coming from the new ore had an acid reaction, it was necessary to have sufficient acid strength to avoid neutrality at any point within the charge of ore. For this reason the new ore is covered with the strongest acid solution available, after which it becomes part of the regular system. This high strength of acid causes an added acid consumption.

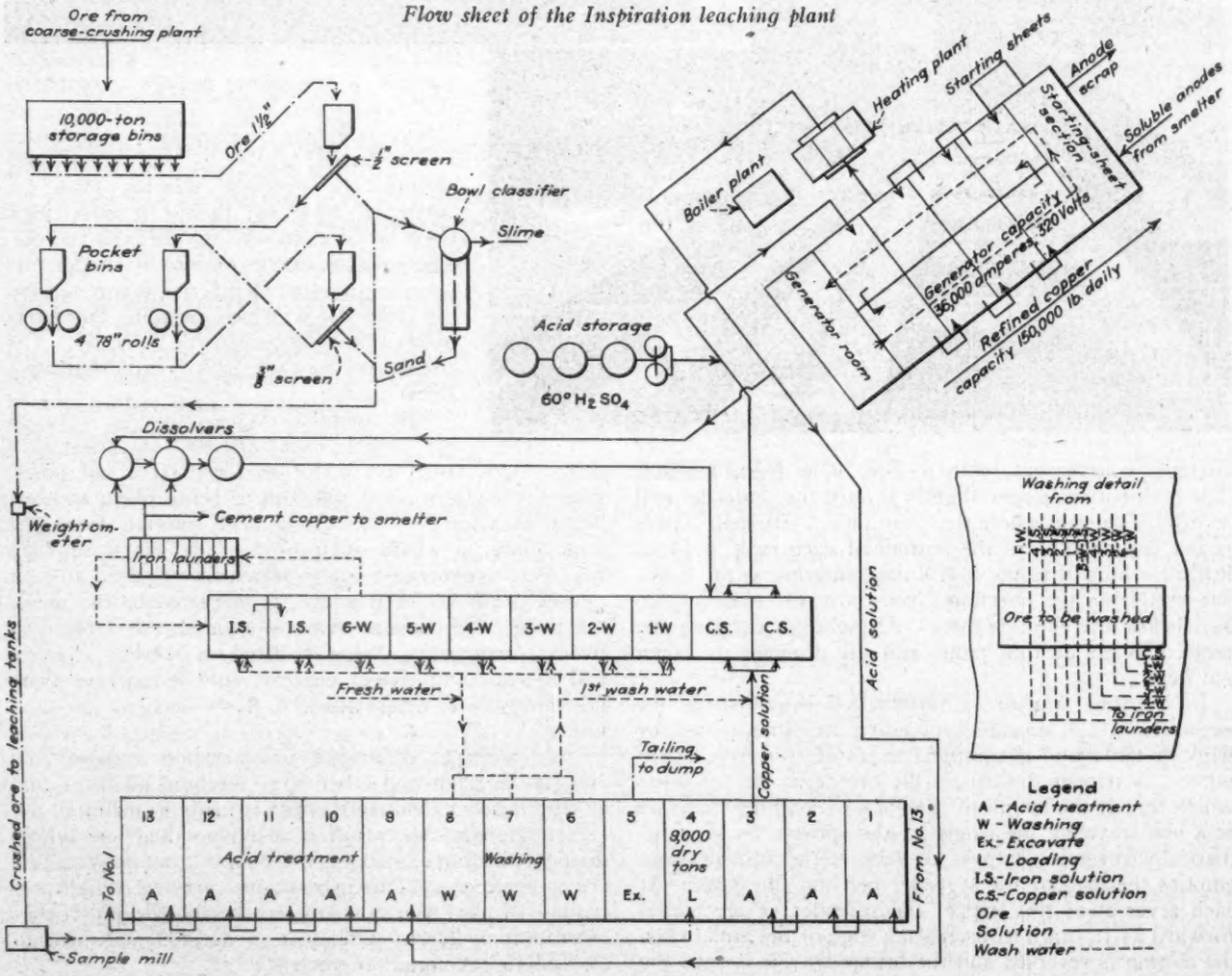
Inasmuch as a definite amount of cement copper production is necessary for maintaining an iron balance, the relation of cement copper to electrolytic copper must change with the total production. After the limit of tank-house production has been reached, if a larger production is wanted, all excess copper is made as cement copper. Therefore, owing to the fact that acid is regenerated in the tank house with the precipitation of electrolytic copper, but is in reality actually consumed in dissolving copper which is precipitated as cement copper, the amount of new acid added to the system must take up this difference. Thus the distribution of the copper produced affects the amount of acid that is consumed in the process.

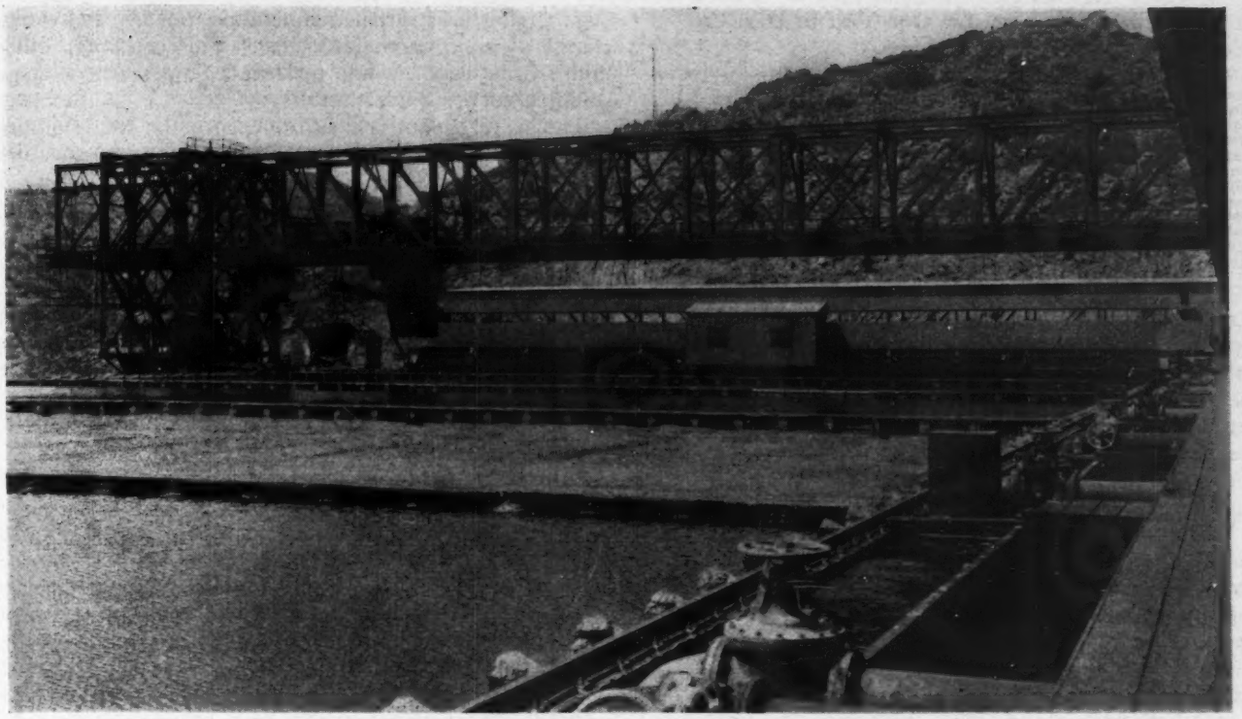
Sulphuric acid of 60 deg. Bé. is added to the system, the consumption per ton of ore in 1927 being 24.36 lb. and in 1928, 20.58 lb., based on acid of 100 per cent strength.

Washing constitutes a very important phase in the operation. This may be pictured in the following manner: A tank of 9,000 dry tons will carry 11.67 per cent, or 1,050 tons, of moisture when discharged as tailing. As the final solution drain averages 20.25 grams per liter of copper, a simple calculation shows that the amount of copper to be washed out would be 42,525 lb. per tank or per day. This represents 29.24 per cent of the daily production.

Three days are used for washing, and every effort is made to wash out as much of this dissolved copper as possible. Ten washes in all are used. The first five are

Flow sheet of the Inspiration leaching plant





Excavator and spreader equipment over the leaching tanks

termed regular washes and are systematically advanced, the first wash going to the main solution system, the second wash becoming the first wash on the next tank to be washed, and so on in the sequence noted. The fifth wash is taken from the iron launder stock-solution tank and becomes the fourth wash on the next tank to be washed.

Four iron launder washes follow. The first three of these washes come from the iron launder stock-solution tank. The used wash water is drained to a surge tank which supplies the iron launders. Practically all of the copper is precipitated, and the total iron content is increased at the expense of the copper, acid, and ferric sulphate. The iron launder tailing solution goes to the iron launder stock-solution tank for further use. The fourth iron launder wash is taken from a tank known by this name and after use is advanced to the iron stock-solution tank in the regular manner. Fresh water is used for the last, or tenth, wash. This wash is drained to the iron launders, but the tailing solution is pumped to the fourth iron-solution tank.

Normally, a batch wash is used—that is, the entire wash water is pumped on the ore, circulated, and the washed ore is drained. At times when a leaching tank has a short tonnage, the amount of wash water available is more than sufficient to cover the ore and to circulate; then, a piston or displacement wash is substituted.

The question of the relative efficiency of batch washing and displacement washing has been the subject of much argument. All conditions considered, batch washing is thought to be more positive if there is any doubt as to the rate of percolation through the ore. The correctness of the washing system is reflected by the water-soluble copper left in the tailing, which is often less than 0.005 per cent. Results are reported to the second place only.

Early in test-plant operation the discovery was made that some means of maintaining a desired iron strength was necessary other than that of depending upon the soluble iron in the ore. Normally, the soluble iron in the ore will amount to less than one-half pound per ton. In fact, test-plant results showed that an average of only one-third pound of iron per ton of ore was actually dissolved over a long period. As it was desired to carry about 20 grams per liter of iron in the leaching solutions, the use of the reject solution from the iron launder system was recognized as an excellent method of controlling the total iron content.

The amount of cement copper made has of course a direct bearing upon the iron put into solution by this method. Practical operation has indicated the desirability of making as little cement copper as possible, owing to its higher cost of production; therefore at times a reduction of the waste of iron in the tailing moisture becomes necessary. This is done by advancing the fresh water wash into the iron launder solution system, thereby washing for iron as well as for copper.

As the only plant discard is the moisture in the tailing, wash-water volumes and wash-water advances are carefully watched. Every effort is made to add the fresh water as a final wash water, as it is most valuable at this point. The volume balance for 1927 and 1928 follows:

	Gallons per Ton of Ore	
	1927	1928
Entering moisture (in ore)	11.16	10.66
Fresh water added as wash	24.24	24.09
Total incoming water	35.40	34.75
Moisture in tailing	27.96	28.08
Evaporation and other losses	7.44	6.67
Total outgoing water	35.40	34.75

Solution Is Heated in Winter

In the winter months, from October to May, it is necessary to heat the solution overflowing from the tank house on its way to the leaching system; otherwise a satisfactory extraction of the sulphide copper would not be obtained. This heating is accomplished by steam at 5-lb. pressure flowing through 1-in. chemical lead pipes having a $\frac{5}{16}$-in. wall, which are immersed in lead-lined tanks

Heating Plant Data for One Year in Deg. C.

Month	To Tank House	To Heating Plant	From Heating Plant	Atmosphere
January	27.7	35.2	51.1	8.5
February	29.9	40.0	58.3	11.0
March	32.4	44.5	59.5	11.7
April	31.7	43.5	54.4	14.9
May	33.0	45.8	50.2	19.7
June	35.7	46.1	46.6	24.2
July	37.2	46.7	....	29.8
August	36.6	47.0	....	26.1
September	34.4	43.3	....	23.5
October	32.5	41.2	45.2	19.4
November	30.8	38.9	44.2	16.5
December	26.3	34.4	42.0	7.3

through which the solution flows. In all, 15,120 ft. of pipe is used for this purpose. Two 500-hp. oil-fired boilers furnish the steam. With this equipment, to raise the temperature of a 1,330-g.p.m. flow of solution 15 deg. C. has been found to be possible. One-quarter of the heating surface is used on the inflow to the tank house and three-quarters of the surface are used on the outflow.

Vacuum pumps are used to return the warm condensate to one of two boiler feed tanks where it is tested for acidity before entering the boiler. Whenever acid appears, the condensate is discarded and the leaky coil blocked off.

As the operation has demonstrated the desirability of placing the hottest solution on the oldest ore, the raising of solution temperature may either precede or follow electrolytic precipitation. This is also a means of controlling the ferric sulphate balance, as will be mentioned under the description of the tank house. Operation of the experimental plant demonstrated the fact that a cold solution (approximately 20 to 22 deg. C.) would give a sulphide copper extraction with a normal ore and under normal conditions of between 40 and 50 per cent. By raising the maximum temperature on the oldest ore to 42 deg. C., the minimum temperature would rise to 28 deg., giving an average temperature on any individual charge of approximately 35 deg. This condition, other things being equal, would produce a 75 per cent average sulphide copper extraction.

The heating plant is closed down for the four summer months, during which time the solution temperature averages about 38 deg.

The problem of heating to a higher temperature in winter presents the question of an economic balance. Radiation losses above 40 deg. in wintertime are large, and as a result the cost of raising the temperature 1 deg. increases rapidly. Solution leaving the heating plant at 50 deg., and pumped through an insulated 12-in. lead pipe line 1,500 ft. long, will give an average temperature to the oldest ore of 42 deg.

Method of Tailing Disposal

After a tank of ore has been leached, washed, and drained, it is ready for excavation. A Wellman-Seaver-Morgan bridge-type excavator spans the leaching tanks with the bucket carriage traveling across the long dimension of the tank and the bridge moving the entire length of the thirteen leaching tanks. The operator rides on the bucket carriage. The bucket is capable of lifting approximately seventeen tons of wet tailing, traveling to the end of the excavator bridge and discharging its load through a hopper into air-dump, standard-gage, railroad cars. Three buckets usually constitute a carload, and the number of cars to a train will vary from six to ten, depending upon dump conditions.

Two eight-hour shifts are required to excavate a tank. Two tailing trains operate on the first shift when the digging is easy and fast, but only one train is used on the second shift. During the first year of operation, owing to the inaccuracy of control on the hoist motors of the bucket, the bucket lips tore up the filter bottoms so much

Tailing dump, with the Inspiration concentrator in the foreground

that 4x6-in. timbers laid on the 4-in. side are now placed over the filter boards, running parallel to the long dimension of the tank on 3-ft. centers, to receive the wear of this operation. This necessitates the leaving of a 6-in. layer of tailing in the bottom of the tank at all times. These timbers must be replaced at intervals of five months.

The tailing dumps are from one to three miles down the canyon from the leaching plant, and are referred to numerically. The No. 3, or main dump, is nearly 300 ft. above the bottom of the canyon and the length of the slope from top to toe is 430 ft. Great care is exercised in maintaining the safety of equipment when dumping under these conditions. As the dump is built out, the track is moved by a mechanical track shifter.

In the next and concluding installment of this article, Messrs. Aldrich and Scott will first describe the revision in the flow sheet made necessary by the separate treatment of sand and slime in the leaching plant, and will then discuss precipitation practice.

Co-ordination of Operation and Research at Clarkdale, Ariz.

GEORGE J. YOUNG

RESEARCH, as a preliminary to ore treatment and plant design and to improve practice, has been characteristic of the operation of several mining companies in Arizona. One of the most significant of recent developments in this respect is the organization of a research department by the United Verde Copper Company at its Clarkdale plant. Oliver C. Ralston, for a number of years associated with the U. S. Bureau of Mines in investigation work, is director of this research laboratory, which was started about a year ago. A research headquarters building provides a library, a microscope laboratory, a chemical and general laboratory, and general offices. The plant itself is part of the laboratory; experimental electric furnaces are situated in the foundry, which is equipped with large electric furnaces, transformers, and other facilities, and a six-ton experimental flotation mill is installed in the concentrate filter building near the concentrating mill. Additional experimental apparatus will be installed at convenient places in the plant as it is needed.

No attempt is being made to establish a costly central experimental plant. The background of the research department is a going metallurgical plant in which ore preparation, sampling, storage, milling, concentrate preparation, roasting, smelting, converting, and copper casting are in progress, and a large poundage of copper is being produced daily. Machine and electrical shops and foundry are available for making investigations, as well as an efficient and experienced operating organization.

Research personnel is obtained chiefly from the operating force, but in part from outside the plant. The work promises to be noteworthy, for seldom do research technicians have an opportunity to review critically the operations of a going plant. Results of commercial value should be derived by the company enterprising enough to initiate a policy of this kind, and an improved metallurgical practice should be developed in the copper-producing districts of Arizona.

Recently I had an opportunity for interviewing Mr. Ralston about the initial problems that are being investigated. Flotation occupies an important place in current research studies. Theoretically, the alkaline circuit in the flotation mill contains little dissolved iron, but titration with permanganate solutions indicated a strong reducing power. Other oxidizing test solutions indicated similar results. Calcium hydrate was found to be reacting with the sulphide pulps, especially those containing pyrite, during grinding and flotation. Soluble sulphides and thiosulphates were formed, even though flotation separation was carried out in the presence of considerable dissolved oxygen and excess air. Ultimately these compounds are oxidized to calcium sulphate. Experimenting with synthetic pulps, the prevailing flotation difficulties were found not to be caused by the aforesaid reducing agents; interesting data concerning chemical changes taking place in flotation pulps were also obtained.

The flotation plant is treating schistose ores, its primary function being to eliminate alumina from the smelter feed. About 1,200 tons per day is being treated by flotation, the remaining mine product of 3,800 to 4,300 tons going directly to the smelter. Flotation difficulties have been caused principally by roasted or burnt ores from the fire zones. Finally the operators decided not to send these ores to the mill for treatment, and operating results have thus been greatly improved. Experimentation is now being directed toward separating zinc sulphides from zinc-copper ore and toward improving flotation conditions. The massive sulphide ores of the United Verde mine are extremely fine grained and require fine grinding beyond present commercial limits; over 90 per cent unlocking of desired minerals does not occur until 800 mesh is reached. Subsequent metallurgy adapted to treating impure concentrate or middling must also be developed.

An exhaustive examination of mine ore and mill pulp has been made with the microscope. At first, 400 or 500 hand specimens of ore were examined, but uncertain results were obtained from these, so that now only pulp samples are used. Diamond-drill cores are also pulverized and representative samples of the pulp prepared. Pulp is briquetted with bakelite under heat and pressure, the resulting product being satisfactory for polishing and microscopic examination. Such briquets have fur-

The research headquarters building of the United Verde Copper Company

nished information relative to the degree of crushing necessary to liberate mineral content and have proved more useful than chemical determinations. All flotation products are examined in this way, and on the "tailings" report is entered the proportion of free and locked mineral grains that have escaped. At present about 90 per cent of the sulphide minerals in the mill feed are ground to minus-300 mesh. By elutriation methods that have been developed, material as fine as 800 mesh can be segregated. In addition to this work, the microscope has been used in the examination of diamond-drill bits, steels, and metal failures. The microscope equipment, with accessories and dark room, is excellent, and is indicative of the importance attached to this method of examination in ore-treatment studies.

As some of the copper ores of the United Verde deposit contain commercial quantities of zinc in the form of marmatite, part of the research work is being directed to the flotation treatment of these ores and also to the pyrometallurgy of zinc. A number of small outdoor heat-treating units have been extemporized and placed back of the research building; these include a converter, melting furnaces, and gas producers. For large-scale experiments, a full-size converter stand has been erected close to the foundry. The nature of this research is involved, because clean zinc concentrates cannot be made by flotation and a considerable quantity of zinc therefore follows the copper through the smelter, appearing in the slags, mattes, and converter fume. De-zincing of slags and mattes is consequently being studied thoroughly. Flotation investigation indicates that the middling products are important and will require special treatment in milling.

When the plans for zinc ore treatment are developed, the final product going to the zinc treatment plant will probably consist of copper-bearing zinc concentrates and fume from de-zincing slags and mattes. The imperfect flotation of zinc minerals and imperfect leaching of zinc calcine and fume will be partly counterbalanced by the recovery from pyrometallurgical products.

Two laboratories are being used for flotation experiments: one in the mill, where screening, elutriation, and grinding tests are made, as well as flotation separations in small test cells, and the other in the six-ton experimental mill. Two ball-rod mills, Fahrenwald and Minerals Separation flotation cells, an improved Akins classifier, belt ore-feeder, lime feeder, and dewatering cones comprise the equipment of this small mill. The small mill units have been standardized against the large units of the operating mill, and experimental results therefore indicate closely what can be accomplished on a mill scale. Heretofore, duplication on a large scale of experimental mill results has frequently been difficult, but the intimate contact between the two related lines of work in this instance promises interesting results. Already, sufficient information has been obtained to lead to the formulation of definite plans for an important extension of milling operations.

The personnel of the research staff includes a chief microscopist, an analyst on special work, three flotation investigators with one assistant; two men on zinc pyrometallurgy, two men on sulphur recovery, one man on iron metallurgy, and one clerk.

Probably the most important point in the establishment of the research laboratory at Clarkdale is the separation of research from operation. It is difficult for a mill or smelter superintendent in charge of operation to take on the additional task of directing research. Both mill and smelter superintendents at Clarkdale, however, participate in planning and overseeing the research, but are not responsible for its execution. Thus, there is a coordination of research with operation, though each is definitely headed by men who are specially qualified to function in these respective fields. Such an arrangement is obviously advantageous.

Michigan Geological Survey Active in Six Separate Fields

THE Michigan geological survey has been working for more than 90 years along lines laid down by Dr. Douglass Houghton, the state's first geologist. In Michigan, the survey is one division of the state conservation department. The work of the division, headed by R. A. Smith, state geologist, is separated into six large subdivisions. The first deals with the arrangement and succession of rock strata, the life of past geological ages as shown by fossils, and the arrangement of minerals in the region. Included in this group is the magnetic survey of copper-bearing rocks, geology of the various limestones, soil survey, and investigations of the sand dunes and their movements with a view to control.

For the last two years a magnetic survey of copper-bearing rocks has been under way in the Michigan copper district, and work in this alone is sufficient to keep the field crews busy for a number of years. The work will be of value to the mining companies, inasmuch as it will save them preliminary geological investigation and enable them to plan exploratory and development operations more intelligently.

The second geological subdivision is usually designated as economic geology, in that it deals with mine appraisals for the tax commission and other studies and statistics which frequently have proved to be of immediate benefit to the state. Well supervision, along with oil and gas supervision, makes up the third subdivision, which has been rapidly coming into prominence. Research to discover improvements and new methods for the utilization of minerals is the activity of the fourth group. The fifth subdivision is the bureau of geological information, which is of use to state and federal governments, as well as municipalities and the public. The sixth subdivision of the survey covers topographic mapping.

Discuss Possibilities of Government Assistance for Rand Mines

RUMORS have been plentiful regarding government assistance for the gold-mining industry in South Africa, but up to the present the authorities have been reticent respecting any policy which may be under consideration. Meanwhile, the decline that was being shown in the number of native employees in the mines has apparently been checked, the more reassuring figures providing encouragement for some buying from the Cape and the Continent. Working costs during the last few years have shown a tendency to advance, as a result mainly of the greater depths at which operations are conducted, and the higher temperatures at the lower levels seriously impair the efficiency of the workers.

Tendency of mine costs to increase bears most heavily on the low-grade mines, which are being forced to raise the grade mined. This means discarding big blocks of low-grade material and shortening the lives of properties.

At present the average working cost per ton of ore treated on the Rand amounts to 19s. 9d., or to 21s. 1d. if taxation and other charges are taken into account. Obviously, only under exceptional circumstances can 5-dwt. ore be treated to produce a profit under present conditions. If the estimate that the Rand will still yield gold to the value of £1,000,000,000 is to become a fact, concessions will have to be made to allow the enormous tonnage of 4- and 5-dwt. ore to be milled with a small profit. To grant such concessions would be sound economic policy, for 90 to 95 per cent of the value of the gold obtained would be expended locally in the form of wages, payment of supplies, and taxation. The treatment of these low-grade tonnages would lengthen the life of the various properties by several years, whereas their abandonment would mean unemployment for approximately 10,000 white and 100,000 native workers.—*The Statist.*

Asbestos Mining Methods in Arizona and Canada

MINING methods in the asbestos industry vary according to the geological occurrence of the asbestos, says the U. S. Bureau of Mines, in a recent report. The asbestos in limestone, as it occurs in Arizona, is usually mined by tunnels and lateral drifts, or by some simple system of underground mining following the ore. In the Arizona field the ore is first blocked out and then stoped, the roof, after stoping, being upheld by the waste rock. In this field common practice is to keep the roof close to the asbestos zone and to pick down the ore onto a large canvas after the supporting rock has been removed.

Asbestos in peridotite or large masses of serpentine is generally mined by open-pit methods, as in Canada. After the rock is blasted it is sorted and cobbed, all fiber $\frac{1}{4}$ in. and over in length being bagged as Crude No. 1, and the corresponding fiber $\frac{1}{8}$ to $\frac{1}{4}$ in. in length being bagged as Crude No. 2. The mill fiber, or fiber shorter than $\frac{1}{8}$ in., is separated from the crushed rock by pneumatic and screening processes.

Crude fiber is usually graded by hand-cobbing and sorting, though sometimes the poorer material is screened. The very short fiber that forms the great bulk of the world's production is separated by milling. Mill fiber is graded largely on the basis of screen tests. Screens of 2, 4, and 10 meshes to the inch are used. Sixteen ounces of fiber is taken, and the amounts retained on each screen and that which passes through the last one are recorded after the screens have been shaken in a specified manner for two minutes. Thus 1-8-5-2 would indicate that 1 oz. remained on the 2-mesh screen, 8 oz. on the 4-mesh, and 5 oz. on the 10-mesh, and that 2 oz. passed through the 10-mesh screen.

The volume of waste in the asbestos industry is enormous, for much of the rock broken must be discarded. In the Canadian field, the largest in the world, the average yield per ton of rock mined is 1 per cent of "crude" asbestos and a fraction over 6 per cent of mill fiber.

Rhodesia's Chromite Industry Gaining in Importance

DURING the last decade Southern Rhodesia's chromite production has steadily increased and in recent years almost half of the world's annual supply has come from there, writes W. D. Johnston, in the current issue of *The Mineral Industry,* which was published this fall by the McGraw-Hill Book Company. Two types of deposits are known. Those of the Selukwe district, Matabeleland, occur as irregular bodies often more or less lens-shaped in talc schists and serpentine. The ore contains between 45 and 50 per cent Cr_2O_3 and is utilized in steel making. Other deposits of this type occur in Mashonaland. The second type of occurrence is in regular seams 4 to 10 in. wide in the basic rocks of the Great Dyke. This ore contains in excess of 50 per cent Cr_2O_3 and finds utilization in the chemical trade.

Much controversy is now in evidence over the proposed Umvukwes Railways. The producers want a railway, but, distrusting the permanence of present market conditions, they do not agree to give the guarantees asked for by the government.

Several large American corporations are reported to be acquiring holdings in Rhodesia.

Malayan Tungsten Industry Neglected in Favor of Tin

THE Malayan tungsten industry remained inactive during 1928. Since the decline in the price of wolframite and scheelite immediately after the World War, local operators state that the exploitation of available tungsten supplies is not warranted, as larger profits can be earned from the mining of tin. The U. S. Department of Commerce reports that exports from Penang amounted to only 67 tons of wolframite ore in 1928, a decrease of 31 tons from the preceding year. Of the total 1928 exports, Great Britain took 52 tons and the Continent of Europe 15 tons, compared with 30 and 68 tons, respectively, in 1927. Exports of tungsten ore from the Federated Malay States in 1928 amounted to only five tons, a decrease of 75 per cent from 1927, whereas from the whole of British Malaya exports of 207 tons were shipped in 1928. This total was divided into 100 tons for the Continent of Europe, 82 for the United Kingdom, and 25 for the United States.

Planning and Constructing

a Small-Capacity

Gravity Rope Tramway

ALGERNON DEL MAR

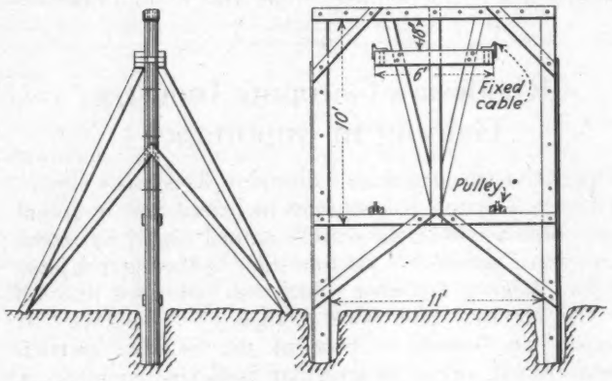


Fig. 1—Sketch of tramway tower

SPECIAL FEATURES of the tramway erected by the Arlington Mining Corporation, in San Bernardino County, Calif., are of interest. The installation was made to convey small amounts of ore to an experimental mill, and not for large-scale or continuous operations. Maximum capacity of the tramway is 6 tons per hour, but 8 tons per shift is the total load placed on it.

The site is in rough, mountainous country, and all construction equipment had to be packed on animals. Weight of the equipment, therefore, was restricted, and the size of the cables limited to the minimum diameter that would stand the calculated strain. The longest span, which was 1,100 ft., determined the size and number of buckets, as only a single bucket could be supported on that span at one time.

Inasmuch as lumber more than 12 ft. long could not be transported, and because splicing was to be avoided so far as possible, the towers were made of 2x6-in. lumber, bolted with ½-in. bolts. The crosspieces holding the saddles, however, were 6x8-in. The method of erecting the towers was simple. From the center mark, two holes 5 ft. deep were dug, each 5 ft. 9 in. from this center and at right angles to the line of tramway. Into these holes the main posts were placed and tamped. The remainder of the tower was built up as shown in Fig. 1.

Between terminals the distance is 5,100 ft., and the difference in elevation, 1,330 ft. The average slope is about 1 in 4. Owing to the grades and distance involved, a balanced tramway was desirable—that is, one with the same number of buckets going up as coming down. Such an arrangement permitted the tramway to be started without the application of power. Eight buckets, spaced at

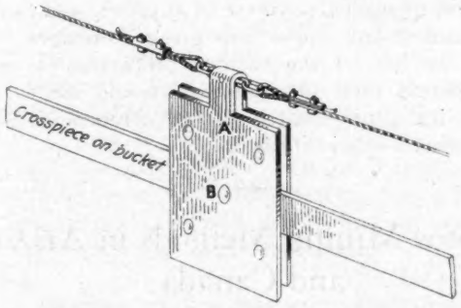
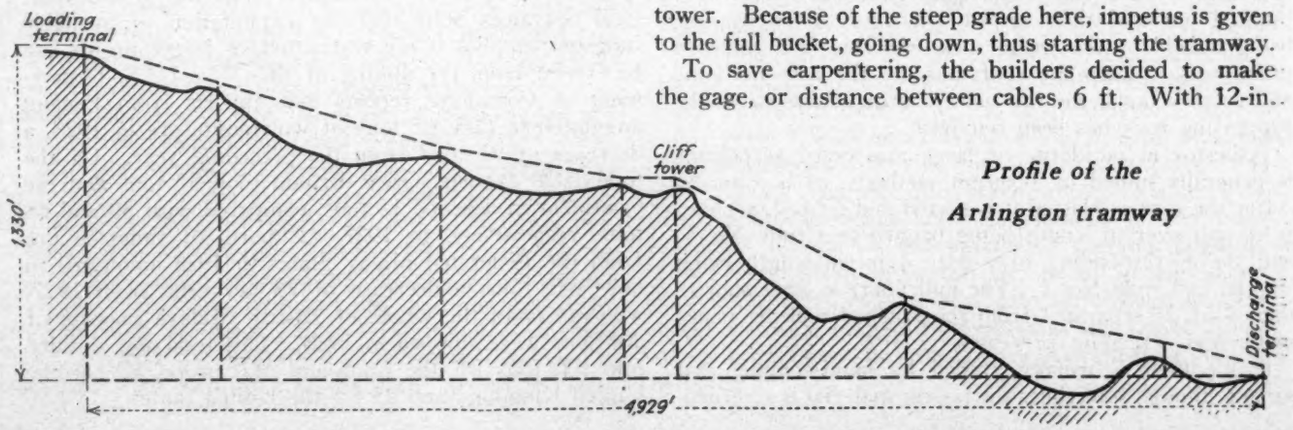


Fig. 2—Bucket-attaching arrangement

equal intervals, are used. While one is being loaded at the upper terminal, one is discharging at the lower terminal. The loading is manual, whereas the discharging is automatic. When two buckets are at the terminals, the two center buckets are on the lower side of the cliff tower. Because of the steep grade here, impetus is given to the full bucket, going down, thus starting the tramway.

To save carpentering, the builders decided to make the gage, or distance between cables, 6 ft. With 12-in.



Profile of the Arlington tramway

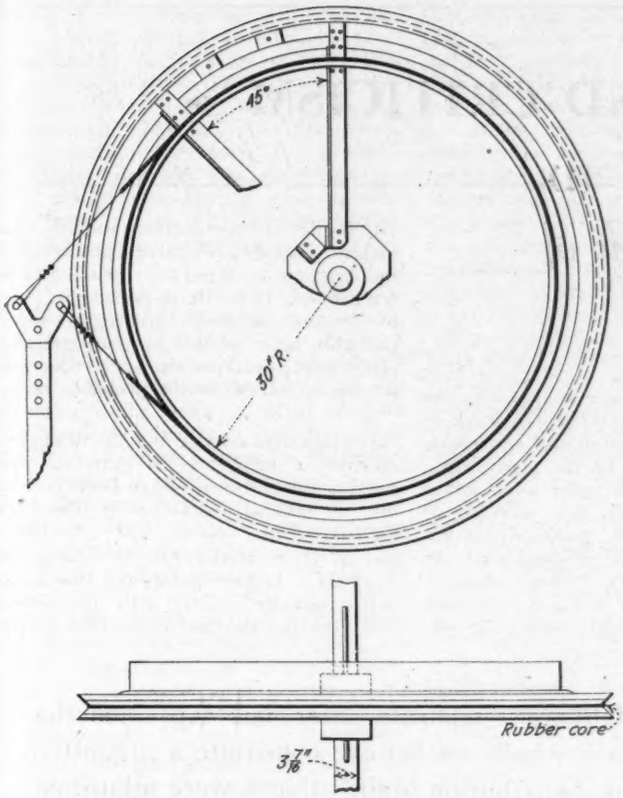


Fig. 3—Details of rubber-cored brake wheel

trolley wheels, this meant that the distance between trolley-wheel centers could not exceed 14 in.; otherwise the trolley would not round the curves at the terminals. The buckets each hold 1,000 lb., but only 800 lb. is loaded into them.

At the loading terminal the speed of travel is regulated by a thermoid brake band, which is 5 ft. in diameter and 3 in. wide. This bears on a brake surface that is bolted to a sectionalized sheave. The sheave has a rubber core, on which the running cable travels. To date, the cable has not slipped, even when the brake is applied suddenly. Details of the brake wheel are given in Fig. 3.

Owing to the steep grades, a detachable bucket was not adopted. Every bucket is fastened to the cable by means of a system of links made from a ½-in. chain. This arrangement, which is shown in Fig. 2, does not wear the cable, and permits turning movements in two directions. The plate *A* is of ¼-in. wrought iron. Four bolts hold the attachment to the crosspiece of the bucket hanger, the hole *B* fitting around the center rivet.

The standing cable is ⅝ in. and the running cable $\frac{7}{16}$ in. Cables at the upper end are anchored in a tunnel above the terminal with a 6x8-in. timber, which is reinforced with a short length of 90-lb. rail. The lower ends of the cables are attached to "boats," measuring 2½x9x3 ft., and resting on a 45-deg. incline track 50 ft. long. With the "boats" at the top of the incline, the cables were each separately pulled as tightly as possible with a 2-ton chain block. The "boat" was filled with rocks and allowed to slide down the incline to the bottom. This gave the necessary tautness in one operation.

Some have wondered how the cables were dragged over the rough, precipitous terrain. This was accomplished with a couple of well-fed, willing burros, a block and tackle, and a ¼-in. steel cable. Below the cliff tower, where the slope is steep, the tramway cable was pulled as far as possible. The ¼-in. cable was lowered from the cliff tower and attached to the heavier cable, which was then pulled up the remainder of the distance with the aid of the burros.

American Mining Opportunities in British Africa

BRITISH AFRICA as a whole is relatively open to American mining operations. By treaty, Americans have the same rights as British citizens in the Mandate of Cameroon, Togoland, and East Africa. In the Gold Coast, Ashanti, Nyasaland, and Nigeria no aliens are granted the right to explore for or exploit mineral oils; in Rhodesia diamond mining (except alluvial) is a monopoly of the DeBeers Consolidated Mining Corporation; and in Nigeria there is a discriminatory duty on the export of tin. In the rest of British Africa, although exploring or mining is nowhere free, there is no apparent legislative or administrative discrimination against ctizens of the United States.

An analysis of the mining laws of British Africa, by John W. Frey, associate mineral economist, has recently been published as Information Circular 6,105 of the U. S. Bureau of Mines. The mining laws of the Union of South Africa have not been consolidated, and the laws passed by the various colonial governments are in force in the several provinces. There are no restrictions, legislative or administrative, in force in the Union that apply to aliens and not to nationals. Although the government allows the diamond companies practically to control the mining of diamonds, this control has been acquired progressively over a number of years and is not a granted monopoly.

Information is given separately as to the mining regulations in force in the Transvaal, the Orange Free State, the Cape of Good Hope (including Bechuanaland), Tanganyika, Zanzibar, Kenya, Nyasaland, the Gold Coast, Ashanti, Sierra Leone, Nigeria, Uganda, Southern Rhodesia, Northern Rhodesia, and South West Africa.

Sponge Iron as a Precipitant of Lead and Copper

POROUS properties of sponge iron have been utilized by the U. S. Bureau of Mines in a series of experiments looking toward the improvement of the process of precipitation of lead and copper from solution. The sponge iron is substituted for coarse scrap iron, which is relatively awkward to handle and exposes a small surface to pregnant solutions. Products containing more than 80 per cent lead were made, and valuable information relative to the precipitation of copper from various solutions was obtained. The study was largely one of the rates of diffusion of metal ions in the solutions and through the metallic coatings surrounding the sponge iron particles. To remove completely the valuable metals from solution, and at the same time to obtain a precipitate of good grade, the precipitant should be almost completely consumed. These practical ends are usually accomplished by having the two substances involved pass each other countercurrently. Results of the experiments are described in Bulletin 281, by G. L. Oldright, H. E. Keyes, Virgil Miller, and W. A. Sloan, issued recently by the Bureau.

COMMENT AND CRITICISM

Origin of the Frood Deposit of International Nickel

To the Editor of "E.&M.J.":

The article on the Frood deposit of International Nickel by Dr. C. V. Corless in the March *Bulletin* of the Canadian Institute of Mining and Metallurgy contains interesting data, and sugguestions are made as to why the deposit varies in composition with depth.

I wish to call your attention to a possible interpretation of a set of facts that may have a hypothetical bearing on the problem. This interpretation does not ask one to believe that, because the atomic weight of copper is a few units higher than that of nickel and iron, it, with its concomitants, iron and sulphur, settled out first as liquid chalcopyrite. The actual compounds that exist in the deposit should be dealt with, not the single elements of one of these compounds. Chalcopyrite is specifically lighter in weight than either pentlandite or pyrrhotite. Unless it is considerably more compressible than these minerals, chalcopyrite should still be the lighter even at great depths. The laws of gravity appear to be invariable. Besides, an idea such as suggested by Doctor Corless hypothesizes a liquid condition at high temperatures. No one knows if chalcopyrite can exist as such in the liquid condition, nor is it clear from existing data that chalcopyrite would prove to be immiscible with other liquid sulphides present. At any rate, if a theory of magmatic differentiation may be legitimately applied by geologists, the question as to how the differentiation arose is of interest. I do not hold, *per se*, that the Frood deposit is the result of magmatic differentiation, but I rather wish to point out a possible interpretation that might aid thinking, were geologists generally to agree that the deposit may be explained in that way.

The subject of mechanics is an old one—apparently dating back to Archimedes. In more recent times the principles of mechanics, and, more specifically, the mechanics of heat, have been applied to a large variety of topics. One of the most fruitful of these applications has been to chemistry.

One or two fundamental notions must be made clear. First of all, changes will occur in any system unless the system is in equilibrium. Such changes as occur are accompanied by a diminution in the amount of available energy of the system. Available energy in a reversible system is termed free energy—it is the maximum energy available for work in the given transformation and is a measure of the tendency of the transformation to occur. For a fuller explanation of these matters you are referred to standard works on thermodynamics, such as Gibbs' "Thermodynamics" or Lewis and Randall's "Thermodynamics." The ability of a gas to do work of any kind—chemical work, for example—is proportional to the logarithm of its partial pressure at a given temperature.

Geologic processes are supposed to require a long time for their accomplishment. If this is true, the separation of chalcopyrite in considerable quantity at depth in the Frood deposit would be brought about with the attainment of a condition of equilibrium, or near equilibrium, at any rate.

Now, consider a few facts in somewhat further detail. One of the most widely distributed substances in the earth's crust is water. It seems to be inherent in igneous rocks. Even after prolonged ignition, a further period of heating will yield traces of water. Water is an oxidizing agent under the right conditions. Pyrite is probably the most common sulphide mineral in ore deposits. In any discussion one may assume that sulphides of iron are present, and to consider the bearing of certain reactions with the sulphides of iron becomes of interest. The action of steam on iron sulphide produces hydrogen sulphide, hydrogen, and magnetite according to Thompson & Tilling (*Jour.* Soc. Chem. Ind. Vol. 43, 1924), who give the reaction as

$$3\,FeS + 4\,H_2O = 3\,H_2S + Fe_3O_4 + H_2$$

at a temperature of 600 to 700 deg. C. At higher temperatures, sulphur and sulphur dioxide are evolved, and whether the reaction as stated takes place may be questioned. If pyrite is present in place of ferrous sulphide, hydrogen would probably be combined as hydrogen sulphide, and a reaction similar to that with ferrous sulphide would probably occur.

Certain data concerning the desulphurization of sulphides—of pyrite to pyrrhotite, for instance—have been pointed out in several instances by Geofffey Gilbert (*Econ. Geol.*, Vol. 21, 1926) and by B. S. Butler (*Econ. Geol.*, Vol. 22, 1927). Gilbert points out that magnetite usually exists with pyrrhotite, and cites that the Sudbury nickel-copper ores containing pyrrhotite also carry magnetite. Doctor Corless, unfortunately, gives no information in regard to magnetite in the Frood ore, nor on its variation in amount with depth in both the orebody and in the incasing rocks. At Anyox, B. C., ores that contained pyrrhotite also contained magnetite, and, furthermore, the pyrrhotite-bearing ores were sometimes associated with iron-bearing silicate minerals. The ores at Copper Mountain, British Columbia, that contain bornite carry a small amount of magnetite. Bornite may be regarded as a copper-iron mineral, not saturated with sulphur. A copper-nickel ore from Bird River, Manitoba, with which I experimented, contained magnetite as well as pyrrhotite, chalcopyrite, and pentlandite, and was associated with iron-bearing silicate minerals. The presence of magnetite would seem to be common.

Consideration is now directed to one or two other reactions:

$$Fe_3O_4 + FeS = 4\,FeO + \tfrac{1}{2}\,S_2$$

Preliminary calculation of the free energy shows that this reaction tends more and more to occur as the temperature is raised. It also tends to be suppressed in running from left to right if the pressure of sulphur vapor is raised. In the presence of silicates or silica at

Mr. Halferdahl, in a separate letter, has explained that these comments, which we believe constitute a suggestive and interesting contribution to the subject, were submitted, as discussion of Doctor Corless' paper, to the Canadian Institute of Mining and Metallurgy, but that they were returned because he is not a member of that society. Under these conditions, *Engineering and Mining Journal* is glad to afford Mr. Halferdahl the hospitality of its columns.

relatively high temperatures, and possibly high pressures, iron-bearing silicates could form from FeO. The action of ferrous sulphide on magnetite gives sulphur dioxide; also with production of ferrous oxide, and this reaction is suppressed by increasing the pressure of sulphur dioxide. As is well known, SO_2 reacts with H_2S to give sulphur and water vapor. The reverse reaction can also occur, depending upon conditions.

The action of sulphur dioxide on ferrous sulphide is to give magnetite and sulphur. An increase in the pressure of sulphur vapor will tend to limit the running of the reaction. Most of these reactions do not occur perceptibly below a red heat under normal conditions.

However, a reasonable assumption is that elemental sulphur or hydrogen sulphide, or both, could be formed under the conditions existing in a large mass of slowly cooling material, if a seal for gases existed to prevent passage of gases too easily to the atmosphere. These are assumptions, be it noted, and their validity may be seriously questioned.

The geophysical laboratory at Washington has ascertained that pyrite decomposes into pyrrhotite and sulphur in a certain temperature range. Furthermore, by passing sulphur vapor at suitable pressures over pyrrhotite at certain temperatures, pyrite is formed. Similar work has shown the conditions for the stable existence of covellite in the presence of sulphur vapor. An increase in the pressure of sulphur vapor permits the existence of pyrite and covellite at higher temperatures without decomposition. Liquid condition of the pyrite or covellite or pyrrhotite is not essential. Of course, at enormous pressures, a certain degree of plastic flow is possible, and this condition is enhanced by a rise in temperature. Publication 595 of the Geophysical Laboratory states that chalcopyrite, $CuFeS_2$, is stable at about 610 deg. C., under a pressure of 453 mm. of sulphur vapor. The regions of stability for each compound are in general not the same, but a certain overlapping occurs, so that, at some interval of pressure of sulphur vapor and of temperature, chalcopyrite and pyrite should coexist; and, at another set of analogous intervals of temperature and pressure, chalcopyrite and pyrrhotite should coexist. Within a narrow region the three minerals may coexist. The stability conditions for pentlandite do not seem to have been investigated, but here, again, it should be true that analogous intervals of temperature and pressure exist for stability of this mineral. The Geophysical Laboratory has shown that pyrrhotite is changed to pyrite in the presence of hydrogen sulphide at atmospheric pressure at 550 deg. C. One may expect that covellite, chalcopyrite, and other sulphides would exhibit intervals of stability, depending upon temperature and partial pressure of hydrogen sulphide, hydrogen and/or water vapor that is present, and of sulphide dioxide.

If a large mass of material contains sulphur, sulphides, and water—and hydrogen sulphide, perhaps—and in a more or less fluid or plastic condition, but slowly cooling, the conditions for equilibrium between reactive components of the mass will be subject to change as cooling progresses. If, at some depth in the body of material, the pressure of sulphur vapor and the temperature are also right, some one sulphide might be more stable than the others, or perhaps two sulphides or sulphide solid solutions, solid or possibly semi-fluid, would coexist together. These sulphides would become stable phases, and should be "salted out" of a more or less dispersed homogeneous phase of several sulphides of the mass. At another depth in the same mass the pressure of active gases, such as sulphur and hydrogen sulphide and water, may be considerably different, and here another mineral or perhaps two minerals would tend to predominate. Pyrite could give up sulphur to form pyrrhotite, and the sulphur go to form chalcopyrite or some copper sulphide not fully saturated with sulphur. Liquidity, as ordinarily understood, is not essential to such "salting out," but conditions of plastic flow should facilitate aggregation into relatively large masses of immiscible sulphide bodies. The work needed to cause aggregation of one sulphide will, in general, be different from that of another sulphide, and will be influenced by the kind of gangue present.

In the absence of definite data, but remembering that the heat of solution of sulphur in ferrous sulphide to form pyrrhotite, a solid solution, is considerable, and that chalcopyrite is ordinarily a stable sulphide of copper—not being easily oxidized—I suggest that the conditions of temperature and partial pressures of active gases were such that chalcopyrite formed more readily than other sulphides at depth. Having become a definite phase, its aggregation into masses occurred. And aggregation of like substances into larger bodies is a widely known phenomenon. This should proceed more readily at depth, where the pressure is greatest. If the right conditions existed, elimination of iron as sulphide at depth might have been accomplished by oxidation to ferrous oxide, which, united with silica or silicates to form iron-bearing silicates or cause oxidation, might have resulted in magnetite, with a certain consequent concentration of copper. The reactions for the oxidation of iron have been given above.

The absolute limits to the conditions for "salting out" are not easily determined from the meager and fragmentary data. But, Mr. Editor, if geologists seriously grant the possibility of the operation of a hypothesis of magmatic differentiation, the action of differentiation is certainly accompanied by energy changes or transformations, and no change is possible without a change in available energy. Among such energy changes none are perhaps more important and frequent than those accompanying the wide array of physico-chemical phenomena.

The suggestion made here is sketchy, and I ask your indulgence in reading it. It will be easily apparent that much more could be written in elucidation of this subject, both to support the suggestions given and also to discredit them.

I am not a geologist, or I probably would not have the temerity to attempt the task of presenting a suggestion to those of august and weighty experience in geology. I am merely a student of chemistry. A. C. HALFERDAHL.

Ottawa, Ont., Canada.

Relation of Wages to Efficiency

To the Editor of "E.&M.J.":

O. Henry, in one of his Central America stories, makes a certain Billy Casperis say that "It is the right of every American to dress up, drink and be dreadful on the Fourth of July." Warrant being found under the same charter rights, it is, or ought to be, the privilege of subscribers to write in and wallop the editor on fitting occasions. This prerogative I now exercise.

My excuse is an editorial in a recent issue concerning the legislation now under consideration by the Mexican government respecting wages in Mexico, the provocative agency being the last sentence in which it is inferred very plainly that high wages follow high efficiency. I suggest that you give some reflection to the relation of efficiency and wages in American and any other country you may think of first, giving due effect to the order in which efficiency and high wages have climbed the ladder.

Having done this, reflect further that the same "furriner" comes to this country, receives much higher wages, and necessarily works at higher efficiency. He is, so far as I have been able to determine, still the same alien—he still has the same race characteristics and tendencies, and remains in possession of the same physical tools with which he started life. Why does he work at the alleged high efficiency prevailing in America (if this assumption isn't too great a strain) and why did he not work at the same degree of effectiveness at home? To me it appears that the compensation has a great deal to do with this. Necessity is the mother of invention. High wages in this country did not, I asseverate, follow high effiency, but rather, the high cost of labor, due to the rapid expansion of the country, gradually forced an efficiency commensurate with the wage paid in order to meet foreign competition based on an entirely different scale of living. The acceleration did not become strikingly noticeable until the late unpleas-

antness with Germany and thereafter, when labor, owing to restricted immigration, became still more scarce, and the excess production of the United States made necessary a still lower unit cost in order that this excess might be marketed in other countries that are in direct competition with goods produced under a lower wage and efficiency.

It is hard for me to imagine a high degree of efficiency without a scale of remuneration based upon the production possible by said h. d. of e. Any feeling of injustice results in a lowering of output without any tangible proof of the decreased effort. It has been said, so I learn, that the cost of labor, expressed in the cost of production, is about the same for all races and places. I do not vouch for this statement, but if you will assure me of sufficient financing, say five or ten millions, I will be only too happy, Mr. Editor, to travel to and fro in the earth, and up and down upon it, conducting a thorough research to establish the real facts concerning this hypothesis, and will, in due season, confront you with an amazing array of figures and graphs supporting a report as long, dull and incomprehensible as a volume of the *Congressional Record.* However, if you are willing to accept this assertion as true, it merely goes to demonstrate that low efficiency is at least as much an effect as a cause of low wages, and that, after allowing for the human factors of any race or nation, higher pay can and will be followed by better efficiency if there be skillful direction.

C. L. COOPER

Jackson, Calif.

[Mr. Cooper did not read carefully the editorial to which he refers. The paragraph to which he objects is as follows: "Capital cannot be stopped at the borders of a country. It will go where labor is efficient, even if expensive; or where it is cheap, even if inefficient. The Mexican government proposes to make labor expensive. It should first take steps to make it efficient." Mr. Cooper understands this to mean that high wages are always a result of greater efficiency, but the paragraph was not written with that in mind, nor do we think it says so. It merely affirms that wages and efficiency are nearly always balancing factors, a statement with which we know Mr. Cooper agrees. Only in the specific case of Mexico do we state that efficiency should precede high wages, and that for obvious reasons. In Mexico, unlike the United States, no scarcity of labor exists. If wages were to be raised suddenly, without an immediate increase in output because of increased efficiency, unemployment would result and wages would naturally have to decline again. On the other hand, increased efficiency without an immediate increase in wages would permit establishment of many industries that are now impossible. That in turn would create a demand for labor that would cause an increase in wages.—EDITOR]

By the Way

Mining at the Grassroots in French Battlefields

WHEN a geologist speaks of the recent intrusion of an orebody, he means a little affair of a thousand million year. In northern France, however, exploitation of what might be called "disseminated" bodies of "native" copper, lead, and iron, which have been deposited within the last fifteen years, is now under way. These bodies are found over a tremendous area and at a comparatively shallow depth. Production from one department last year was about 1,000,000 lb. of copper and lead. Further details, as reported by The Associated Press, follow:

"Copper, lead, and iron, shot by the cannon of all the armies, are gathered by a peace-time army of 5,000 men and women. Other thousands of boys and girls help out family budgets with their daily load of metal.

"For ten years this has been going on and it probably will continue another five years. Every time a field is ploughed or harrowed more metal comes to the surface.

"The government, theoretically owns all this, but contractors have bought the right to it. There are crews of expert workers who pass from farm to farm, sometimes picking up the metal themselves and sometimes buying the heap already gathered by the farmer and his family.

"The enormous quantity of copper, thousands of tons, consists mostly of empty cartridges, an evidence of the millions and millions of shots fired by the armies that fought over this ground for more than four years."

Not Adding to The Black Man's Burden

"FANTASTIC reports" of distressful labor conditions in South Africa are without a basis of fact, according to a recent statement published by the New York *World,* which quotes the Amsterdam Bureau of the International Federation of Trade Unions as follows:

"As a rule, far too little attention is paid to conditions in the colonies and protectorates. Sometimes, however, it happens that exaggerated reports get about which do more harm than good to the workers' cause. Recently there have been wildly fantastic reports in the press concerning conditions in the mines of Southwest Africa. It is rumored that the negroes in these mines are grossly mishandled. For instance, that they are induced to conclude impossibly bad agreements with the companies through the lure of a free wife offered by the employers.

"The Labor Union of Southwest Africa, which is affiliated with the I. F. T. U., is much annoyed by these reports. It informs us that if a white employe in the service of the mining company strikes a native he is liable to criminal prosecution and is, furthermore, discharged, this being in accordance with a law which has been in force for over twenty years. On the whole, the blacks are humanely treated in Southwest Africa, declares the Centre. Their working hours in the Tsumeb mine (the one concerning which the above absurd statement was made) are eight hours, and they are paid extra for overtime, like the whites."

We are glad the report isn't true. Imagine the position of the mining executive who, in addition to his professional duties, had to act as matrimonial agent, court of domestic relations, referee in divorce proceedings, and godfather to the whole wide world.

Peculiarity of "Zinc-Base Paint"

A MAN'S puzzlement over a fence post which he had painted black but which turned white every night was the starting point of a program of research which has culminated in the discovery of a number of chemicals having this remarkable chameleon-like property scientifically termed phototropy. Information regarding these chemicals has now been made public by the American Chemical Society. The famous fence post was painted with a "pigment having a zinc basis." It would turn black soon after sunrise each morning, only to turn white again when darkness came. Many explanations have been given for the phenomenon, but scientists are not yet agreed as to the cause of it. They have, however, found several other substances besides the zinc sulphide, which was in the paint on the post, that will also change color with the light. Most of the known phototropic liquids are solutions of colorless derivatives of certain dyes. The solutions are practically colorless in the dark, but turn the color of the parent dye when exposed to light. —*Science Service.*

Ask Professor Einstein

THE INCREASING complexity of scientific knowledge requires the existence of a complicated and comprehensive terminology. Engineers are reared from early youth on such articles of verbal diet as miles-per-second-per-second, and millions-of-gallons-per-day. To handle their problems, they must employ words that express simultaneous activity in more than one dimension.

Recent reports from Nevada prove that the divorce-producing state is the present scene of the ever-receding frontier of lexicographical possibility. Words that involve four or five dimensions are in common usage, words that evoke fascinating, advanced theories. The last news item of note in this respect, which came from Beatty, told of two miners who are "Reported to be sacking ore on the $150-ft. level. . . "

Digest of Current Literature

Beryllium. J. Schlenzig. *Metallbörse.* June 15, 1929. Increasing demand for beryllium metal for aircraft construction has led to active prospecting for new sources of beryl ores. The beryllium alloys are especially in demand in America. Prospecting has been particularly active in the Leysdorp district in South Africa and in the Ural Mountains (Soviet government). The Somerset mine of South Africa (Leysdorp) is estimated to have about a million tons of beryl rock available for open-pit mining. Its revenue from gem stones is enough to pay all costs of producing 1,200 tons per month of beryl rock. This mine has accumulated about 10 tons of beryl crystals, not of gem quality, shown by analysis to contain about 540 kg. of the metal. The properties of beryllium which make it so desirable in aircraft construction are its low specific gravity (aluminum 2.7, beryllium 1.8), its great toughness and its thermal behavior. The extraction of the metal from ores is best accomplished by electrolysis. Several processes and electrolyte compositions for this purpose are known. One electrolyzes a fusible double salt. The Borchers method uses a fused mixture of the chloride with a chloride of an alkali metal. For extended use of the metal, a cheaper source of ore than beryl crystals is needed. Lower production costs by improvements in methods of obtaining the metal from its ores must also be obtained. Prediction is made that the present position of gem stones and ore will be reversed, the gem stones becoming the secondary object of working the beryl deposits. The Soviet government, with its extensive Siberian deposits, may be expected to hold a deciding influence on the price of the raw material in the future.

Tin in Bolivia. Friedrich Ahlfeld. *Metall und Erz.* July, second number, 1929. Little has been published about the Uncia-Llallagua tin deposit, in Bolivia, although it has been known for about 20 years as the richest and most important tin orebody in the world. The entire series of deposits is related to the lesser rhyolite occurrence. There are four main veins and about 40 small veins. The most important is the San Jose-San Fermin vein, which is more than a kilometer long and 1 to 3 m. wide. Three formation phases can be recognized, one above another. The principal occurrence is of black cassiterite and pyrites in a quartz gangue. Other occurrences include covellite, chalcocite, chalcopyrite and some tin sulphide ore. There are also large phosphate deposits. There are very few outcrops of the tin ores; most of the veins lie well under the surface (120 to 500 m.). The ore is worked on a contract system, payment being made by the cubic meter. Mine timbers, which are needed in considerable quantity, are brought from Oregon. Hand labor has been displaced by the use of pneumatic hammers, electric drilling not having been found satisfactory. The dynamite consumption is about 7 kg. per running meter. Owing to rapid exploitation of the richest ores, the tin content has decreased from a prewar average of about 12 to 15 per cent to 9 per cent in 1924, 4.55 per cent in 1926, 4.14 per cent in 1927, and 3.5 to 4 per cent in 1928. The discovery of the rich Veta Contacto vein in 1926 prevented an even greater decrease. Bismuth and tungsten were formerly recovered, but the ores are now too poor in these metals to make their extraction profitable. Statistics of the workings are cited.

Upper Silesia. F. Quincke. *Zeitschrift fur angewandte Chemie.* Aug. 10, 1929. Industrial applications of the findings of chemical research, as practiced in Upper Silesia, are reviewed. They include, in addition to an active iron and alloy steel industry, the production of aluminum, copper, lead, nickel, and zinc. Much of the development recorded has been in the direction of apparatus and process improvements leading toward larger production; but advances have been made in the chemistry of the industries also. Among the earliest of these were the processes of Kiliani, Heroult, and Hall for obtaining aluminum by fused salt electrolysis, and the electrolytic method of refining copper. Lead metallurgy was greatly advanced by the introduction of the Dwight-Lloyd apparatus, and by sulphuric acid manufacture from flue gases; and in refining, the oxidizing melt process is finding a welcome auxiliary in the treatment of molten lead with a fused soda melt containing chlorate. Better understanding is still needed of some of the lead reactions, particularly the effect of added gypsum on lead silicate formation, in working up lead ores. Some progress is being made in improving the efficiency of zinc roasting, and a certain degree of success has been attained with chloridizing roasting, electrothermal distillation, and electrolytic refining. In the main, however, the old Wetherill process must still be considered preferable in many cases for zinc production, in spite of the high fuel consumption and relatively low yield. In nickel metallurgy also need for improvement exists; the industry in Upper Silesia depends on the Mond-Langer carbonyl process, which is not wholly satisfactory.

Rare Earths. Weidert. *Zeitschrift für angewandte Chemie.* Aug. 17, 1929. Some of the rare earths, obtainable from monazite sands by the tedious process of fractional crystallization, are coming more and more into demand, and some cost reductions are being effected. Mesothorium has some uses as a radioactive material; Auer metal, made from these rare earths, is useful as a pyrophoric metal; and glass makers are using increasing quantities of rare earths. Neodymium and praseodymium, the two most important rare earths in glass compositions, are so difficult to separate that it was long believed the mixture was an element, which was called didymium. The two earths are useful in glass on account of their selective absorption of light rays, making them valuable components in color filters, glasses to correct partial color blindness, and ornamental glass. Cerium and zirconium are also useful in glass. The earliest commercial use of the rare earths—namely, in gas mantle manufacture—also continues to create a considerable market for the products of the monazite sands.

Alsatian Potash. *L'Industrie Chimique.* July, 1929. Two extensive projects for exploitation of the Alsatian potash deposits are in progress, one by the French government and one by the Kali-Sainte-Therese mines. The latter was a private company, of French and Alsatian ownership, even before the war. The government workings are in properties which were mostly German-owned. They remained idle until a law of 1924 permitted the government to take over the enterprise. Twelve mines are being worked by the government, and six by the Kali-Sainte-Therese interests. Both market their product through the same selling organization, the Société Commerciale des Potasses d'Alsace. Most of the mines have two working strata, one containing about 18 per cent sylvanite, and under it, about 650 m. deep, one which contains about 12 per cent sylvanite.

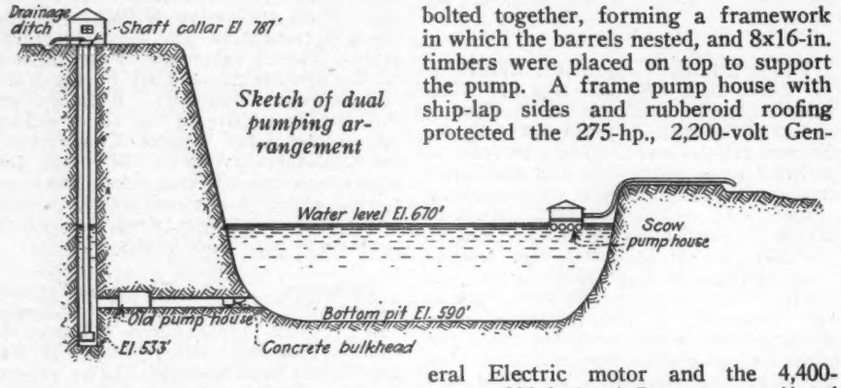
Tungsten. J. A. M. van Liempt. *Zeitschrift für anorganische Chemie.* July 20, 1929. Quantitative reduction of sodium tungstate with hydrogen at 900 deg. C. has been reported. Long experience in the laboratories of the Philips Gloeilampenfabrieken in Holland indicated that this was not a practicable method of making metallic tungstein with any such temperature limitation, and trials were therefore made of the reported experiments. At 900 deg. C. the reduction was slightly less than 20 per cent complete; a temperature of 1,100 deg. C. was necessary to effect a practically quantitative reduction. Potassium tungstate is not reduced by hydrogen even at 1,100 deg. C. The reduction was carried out in a molybdenum furnace, heated with mixed gas.

Titanium Minerals. *Revue de Chimie Industrielle.* August, 1929. The ilmenite deposits of Travancore Bay are being extensively worked for their titanium content, largely to supply the increasing demand for titanium pigments. One of the major products is Thann white, a special titanium oxide pigment, made by the Blumenfeld process at Thann (Upper Rhine region). The ilmenite, an oxide of iron and titanium, is converted to sulphate; the ferrous sulphate is precipitated by cooling and recovered as a separate product. The titanium sulphate is hydrolyzed to the oxide, which is then filtered, washed, dried and ground. Also, the ilmenite ore serves as raw material for production of alkali metal titanates and of titanium oxalate, sulphate, and other compounds.

Stream Pollution. Werneburg. *Braunkohle.* Aug. 31, 1929. The problem of stream pollution from waste waters of mines and factories is discussed, particularly as relates to owners' responsibility under the German statutes. Requirements of the code with respect to preventive measures are stated. Under the Prussian law, a mine owner is responsible for any damage caused by effluent from his mine, regardless of whether or not his mine extends under the damaged property, whether the owner is personally to blame or not, and whether or not the damage could have been foreseen.

COST-CUTTING INNOVATIONS

Power-Rate Saving Builds Pumping Plant



Sketch of dual pumping arrangement

L. C. MOORE
Hibbing, Minn.

DURING the three years from 1925 to 1928, when the Holman-Cliffs mine, at Taconite, Minn., was inactive, over 1,000,000,000 gal. of water collected in the pit, which had to be removed between Dec. 1, 1928, and May 1, 1929. Plans were made to pump from both the shaft and pit, as shown in the sketch. The shaft was lined with concrete, and in it was installed a Layne & Bowler 24-in. deep-well pump with 4,200 gal. capacity against 200-ft. head. This pump was started on Nov. 28 and stopped on April 26, when the shaft was pumped dry.

In the pit was installed a scow built of 49 steel oil barrels and 65 8-in. cedar poles, 20 ft. long. The poles were bolted together, forming a framework in which the barrels nested, and 8x16-in. timbers were placed on top to support the pump. A frame pump house with ship-lap sides and rubberoid roofing protected the 275-hp., 2,200-volt General Electric motor and the 4,400-g.p.m., 200-ft. head Cameron centrifugal pump. With all equipment on the scow, and the pipe lines full, the floor of the pump house was about 6 in. above water level. The scow pump started operating on Jan. 24, and threw almost 6,000 g.p.m., the head being reduced. This increased the load on the motor to 342 hp., but the temperature during January, February, and March ranged around zero and below, which kept the motor cool enough for the overload. The 350-hp. vertical Westinghouse motor on the Layne & Bowler pump carried 444 hp. during this interval, but was also kept cool with outside air, and gave no trouble.

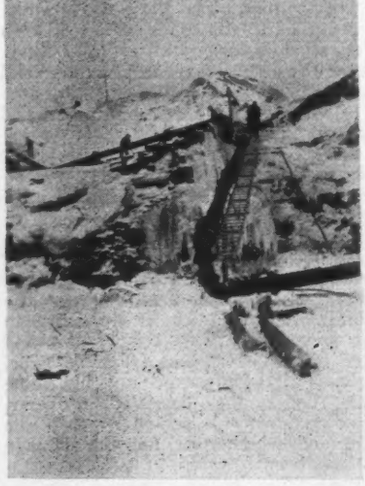
The operators decided to lower the water in the shaft to the drift and to open the two 10-in. valves on the pipes through the bulkhead connecting the shaft and the pit. When the water dropped 60 ft., however, something around the bulkhead gave way, and from then on the level of the water in shaft and pit remained the same.

The large motors and pumps were installed to take advantage of the power-company contract in force on the Mesabi range, which allows a second-class rate of 0.0085 per kilowatt-hour for a 12-hour load during their off-peak periods, and 0.005 per kilowatt-hour for dump-load made from water going over the dam in the fall and spring. By increasing the pump capacity to operate on second-class and dump power rates, a sufficient saving over regular rates was made in power costs to pay for the pumps and their installation. Although the distance between the pumps was about a mile around the pit, one pump man cared for both, and they gave no trouble.

To remove large quantities of water from a pit, the barrel-scow scheme seems to be the most desirable. Maintenance trouble is at a minimum, the cost of installation is low, and efficiency high from the centrifugal, even on a variable head. The accompanying illustrations were taken in January, when the pit installation was made with the temperature at times around 40 deg. below zero.

Economy in Permanent Trolley Lines

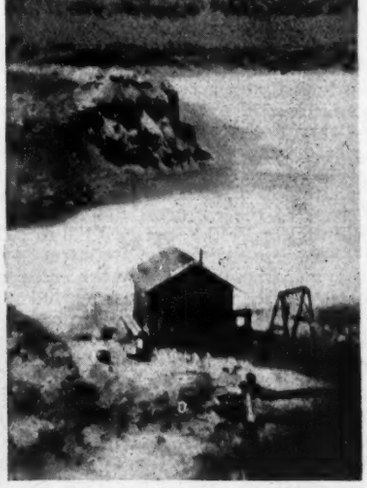
AN EXAMPLE of trolley-wire construction used on a 3,000-ft. stretch of double-tracked main haul graded along the mountainside between the mine portal and the dump house of the

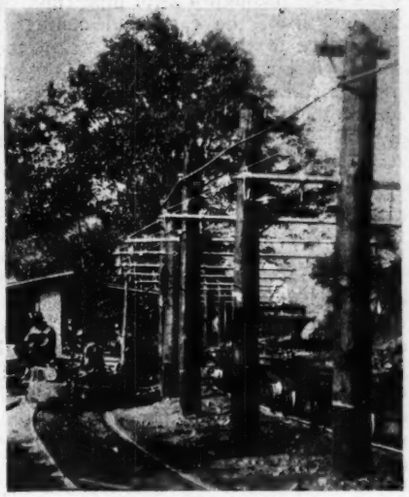


Left—Double swing joints on 12-in. discharge, and ladder attached to pipe. The power cable also follows the pipe line

Right—Holman pit full of water, with scow pump in foreground

Below—The Installing crew





Curve on main haulage at top of incline

Yancy mine, Harlan County, Ky., represents the best that the mine officials found available. After two years of service it still has their indorsement.

The occasion for a new installation arose two years ago, when the original single-track road was changed to double-track and the small trolley posts were found to be badly rotted. The first thought was to set posts on each side of the double track to support spans of pipe or steel messenger wire, but this was ruled out because of the possibility of earth slides might take out the posts on the lower side, because of the lack of firm ground in which to guy these posts if messenger wire were used, and because a pipe span would not provide the desired flexibility.

Single chestnut posts set between the tracks, each equipped with two flexible brackets conforming to specifications of the American Electric Railway Association, were selected. The posts, cut locally, averaging 12 in. diameter at the ground line, are set to a depth of 4 ft. above the ground. Creosote was applied from the base to a point 2 ft. above the ground and also to the top bevels. The body of the pole is painted red.

The spacing is 12 ft. on the straight track and closer on the curves. Adjacent rails of the two tracks are 6 ft. apart, thus leaving a clearance of 30 in. from pole to rail.

Bracket arms are of 2-in. seamless galvanized tubing, 9 ft. 6 in. long on one side and 2 ft. 6 in. on the other. The support rods are ½ in., the messenger strand is $\frac{5}{16}$ in. These parts, the pole castings, outer span holder, guide castings, hangers and clamps were purchased from the Ohio Brass Company. The trolley wire is 6 ft. 6 in. above the rail and 6 in. to the outer side.

Other conductors carried on the poles are a pair of telephone wires and a 1,000,000-circ.mil feeder from the 275-volt substation. Type-P side-attachment mine hangers are used for support of the feeder cable because these were available from some old work that was taken down.

"Even in first cost this construction figures less than if we had used a span and two poles," said Charles Guthrie, mine superintendent. "That way it would have been necessary to dig two holes per hanger."

The flexibility provided by having the trolley wire attached to a messerger strand instead of directly to the pipe is a feature which aids in keeping the wheel on the wire and reduces maintenance by diminishing the shock as the wheel passes over the hanger.

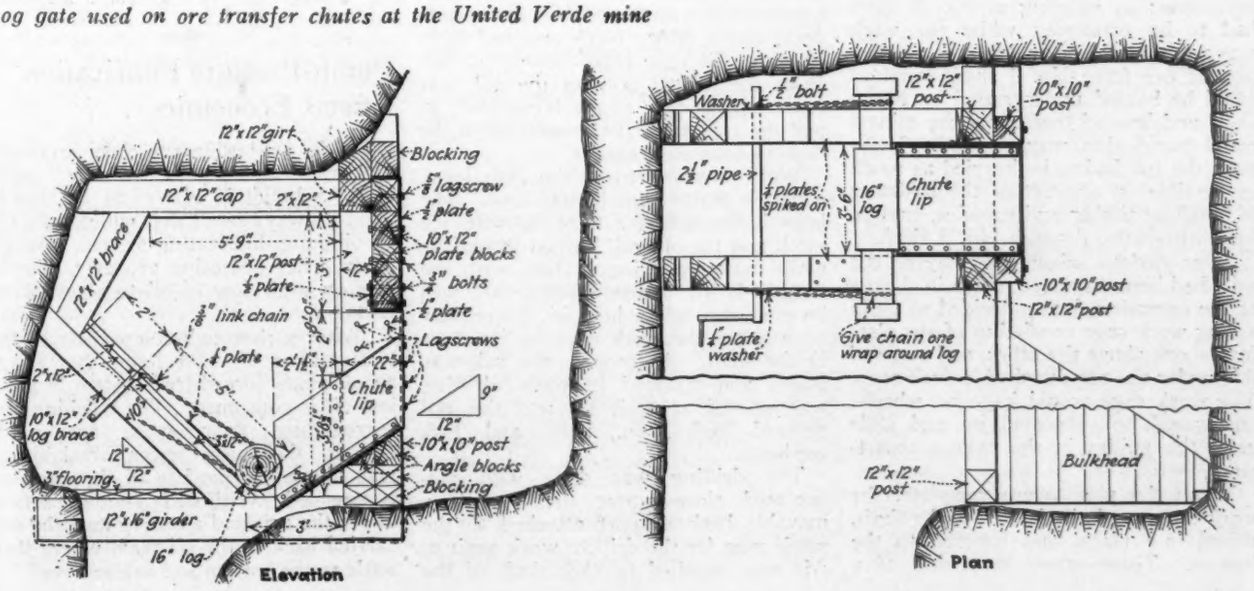
Experience proved the wisdom of using large poles. Several have had three or four inches of the side cut away by contact with a wrecked trip, but none has been broken. Considering stability, durability, and satisfactory service, the installation is far above the average for mine work.—*Coal Age.*

Log Gate on Ore Transfer Chutes Reduces Repair Bills at United Verde Mine

IN HANDLING heavy ore through transfer raises at the United Verde mine, Jerome, Ariz., the ordinary iron chute door was found to be too light for the duty imposed on it. Repair bills became excessive, and, owing to the small opening provided by the door, operating efficiency of the chute was low. To overcome these disadvantages, the log gate shown in the accompanying illustration was devised. Repairs now consist principally of replacing logs, the average length of service of which is equal to 80,000 to 100,000 tons of ore transferred, as compared with 7,000 to 10,000 tons for the old-style chute door. Moreover, the windlass arrangement of the log gate permits the chute puller to stand farther back in a safer position, and, when the chute blocks, gives him more room to work with a bar.

The gate structure is of 12x12-in. posts, 12x12-in. caps, and is armored by steel plates. The chute lip is of metal construction and is set on a slope of 3 vertical to 4 horizontal. Bearing up against the side plates of the chute is a log 16 in. in diameter with the end portions turned down to receive a chain. The turned-down portions of the log roll on ¼-in. plate runways set on an angle of 45. deg. One end of the chain is fastened to the runways and the other to a 2½-in. pipe, which is turned by a crank. Movement of the crank either runs the log out of the ore stream or else allows it to run into the stream, thereby checking its flow.

Log gate used on ore transfer chutes at the United Verde mine



How Savings in Time and Labor Were Effected in Re-railing a 2,520-Ft. Shaft

LESLIE E. DICK
Assistant Superintendent,
Montreal Mining Company, Montreal, Wis.

THE No. 4 shaft of the Montreal Mining Company at Montreal, Wis., is a five-compartment shaft, made up of a 5 ft. 6 in. x 9 ft. 4 in. cage compartment, a ladder compartment, two skip compartments, and a pipe-and-cable compartment. The shaft is inclined 62 deg. 30 min. from the horizontal.

When the old rails in the cage compartment became crystallized and worn so badly that it was necessary to replace them, the operators decided to put in 60-lb. rails in place of the lighter 40-lb. section formerly used. The heavier rails would make a more permanent job, permit the cage to ride more smoothly through the shaft, and make travel in the cage safer.

However, this decision to change the rail section brought another problem. If a rail of the same size were to be put in, the work could be done during week ends and between shifts; but the use of 60-lb. rail made necessary a change in some of the dimensions of the cage. If the cage were made to fit the new rails, it would not fit the old ones; therefore, to make the complete change of rails at one time was the only alternative.

The rails rest upon 6 in., H-section, steel wall plates, 6 ft. apart, on the foot side of the shaft. If the rails could have been clamped to the wall plates, that operation would have simplified the readjustment, but there was no room between the rails and the end plates and dividers, so it was necessary to drill the rails at each wall plate and fasten them with bolts.

To work a crew of men in the cage compartment and hoist ore with the skips at the same time would not have been safe; so hoisting at No. 4 shaft had to be suspended while the work was going on. Fortunately, the production of ore from No. 4 shaft territory could be hauled underground to No. 5 shaft and hoisted there, and the miners could travel that way as well. However, the job had to be hurried as much as possible on account of the difficulty of handling timber and supplies, enough for both shafts, through No. 5 shaft.

After various schemes for laying the rails had been discussed, those in charge of the operation finally decided to build a long work cage consisting of six platforms, one above the other, and suspend this under the regular double-deck cage. The work cage would have no wheels, but would be supported by and slide upon the guides in the cage compartment.

When the plans were complete, the work cage was built, hauled to the shaft, raised into place, and lowered to the bottom. Three crews consisting of a boss and fifteen men on each eight-hour shift were organized. In addition, two landers and an oxy-acetylene burner were employed on each shift. The landers remained on surface to handle

Work cage with six decks used by Montreal Mining Company in changing rails in shaft without interrupting ore hoisting

supplies and load the new rails on the regular cage. To handle the rails in and out of the cage, an air-operated tugger hoist was mounted on the bottom deck, and a pulley block attached by a clamp to the cage rope above the cage. With the middle deck of the old cage removed and part of the bonnet off, to pull the rails from the ground up in the cage was an easy matter.

Work was started at the 28th level, which is the present bottom level. The bolts in the old rails were cut with the torch and the old rail burned in half, to make easier handling. Then, with the tugger hoist, a new 60-lb. rail was lowered through a hole in the regular cage above the work cage, to its place in the shaft. As soon as the rail was gaged and clamped in place, drilling was started at each set and the rail secured with ¾-in. bolts and lock washers.

The drilling was done with air-operated close-quarter drills, with a movable back support attached to the work cage for the drill to work against. Air was supplied to each deck of the work cage through a 2-in. pipe running the length of the cage and connected by a hose to the main air line in the shaft. A hose to attach to the tugger hoist on the regular cage was also connected to the 2-in. pipe line. A ladder the full length of the work cage made it possible to go quickly from one deck to another.

Two heavy chains with hooks on the loose end were attached to the top of the work cage. While working on a length of rails these chains were hooked over the shaft sets, and the connection between the regular cage and the work cage was disconnected. A piece of rail was also passed through the frame of the work cage, resting on a divider and end plate, and this acted as an additional support to hold the work cage in the shaft if the chains failed. This rail was merely a safety precaution, for the chains held the work cage without difficulty. The regular cage thus freed from the work cage was hoisted to the surface over the old rails in the shaft, whenever necessary, and a load of new rails brought down without stopping the work below.

The men, supplies, and the 15-ft. pieces of the old rails removed from the shaft were hoisted in the skip next to the cage compartment. At first the job went slowly, for the work was new and the men were not familiar with the equipment. Five hours were required to install the first two rails, but before finishing the job sixteen rails were put in, or 240 ft. of cage road completed in one eight-hour shift.

Changing the rails in the cage compartment took a little less than seven full days; 168 new rails were put in place in 2,520 ft. of shaft.

The following is a statement showing the cost of changing the rails in No. 4 shaft cage compartment. The cost of brakemen's labor for running the cage and skip hoists is not included:

Cost of making cage	$537.16
Cost of moving cage and putting it in and taking it out of shaft	65.34
Cost of rails	2,648.47
Installing rails	3,793.61
Total	$7,044.58

Pump-Pressure Lubrication Effects Economies

"IT IS my business to order a considerable amount of machinery," states F. A. Schmidt in *American Machinist*, "and I always select that which calls for an oil-pump lubricating system. An oil pump, when operating properly, distributes an even flow of oil to all working parts.

"After a thorough comparison of the two systems, we have found that where an oil-pump forced-feed system is used, less oil is consumed. The machine and surrounding floor space are much cleaner, there are fewer breakdowns, and, above all, the life of the machine is extended. With such a continual flow of oil, the grit and abrasive material are carried back to the oil tank, where they settle to the bottom and are removed."

Personal Notes

J. F. Brophy, mining engineer, of Red Lodge, Mont., visited New York City recently.

H. F. Fay, president of Mayflower-Old Colony, visited the Michigan copper district last week.

Carl O. Lindberg has recently returned to New York City from a professional visit to London.

A. H. Head has resigned as general manager of Pride Mining, operating in the Silverton district of Colorado.

W. C. Capron, formerly mechanical superintendent for Anaconda Copper Mining, at Anaconda, Mont., has resigned.

William McCullough is in charge of operations at the Mountain Top property, near Ouray, in the San Juan Basin, Colorado.

Louis Hirshler, president of the Hirshler Metals Company, sailed from New York for Europe on Oct. 9. Mr. Hirshler expects to return in three or four weeks.

W. J. Quigley, president of the Howe Sound Company, together with **O. R. Whittaker,** consulting mining engineer, of Denver, is visiting the Britannia mine, at Howe Sound, B. C.

Leslie Urquhart, chairman of the board of directors of the Mining Trust, planned to arrive in London on Oct. 12, on his return from the Mount Isa property in Queensland, Australia.

M. C. Butler, who recently returned to Seattle, has been on an inspection trip up the Portland Canal. He examined and submitted reports on several claims on the American side, near Texas Creek.

H. C. Dudley, W. G. Swart, and **W. E. Smith,** all of Duluth, respectively president, vice-president, and secretary of Cusi Mexicana Mining, have returned to Duluth from a business trip to New York City.

H. M. Kingsbury, of San Francisco, sailed from that city on Oct. 10 for Sydney, Australia, en route to New Guinea to make a geological study of the properties of New Guinea Goldfields, Ltd.

T. Burghardt, assistant sales manager of Calumet & Hecla Consolidated, sailed on Oct. 11, from New York, on the "France." Mr. Burghardt will be in France, England, and Germany, on company business.

Albert E. Wiggin, metallurgical manager at Great Falls, Mont., for Anaconda Copper Mining, has been elected to succeed the late **Charles W. Goodale** as chairman of the Montana Alumni Society of the Massachusetts Institute of Technology.

M. H. Merriss, metallurgical engineer, has become associated with the investment banking firm of Julius Lichter & Company, Inc., as manager of the investment and trading departments, with offices at 225 Broadway, New York City.

Charles Rees has been appointed vice-president in charge of mining operations for the Vanadium Corporation of America, according to a recent announcement. Mr. Rees has had experience throughout the world, locating and producing minerals, particularly those of growing importance in alloy-steel manufacture. Upon graduation from the University of Wisconsin, he engaged in geological work. Mr. Rees is well known in the Lake Superior district, where from 1900 to 1911 he was with Minnesota Iron Mining and Oliver Iron Mining. In 1916 he joined the staff of the American International Corporation, and made investigations in Russia, Siberia, China, and Japan. Until the merger with Bethlehem Steel, in 1923, he was with Midvale Steel & Ordinance as geologist and representative in Mexico. In 1924, Mr. Rees became affiliated with the Vanadium Corporation as consulting engineer.

CHARLES REES

Adam R. Gordon, vice-president and general manager of New York & Honduras Rosario Mining, has just returned after an airplane trip through central and southern Europe, ending in Spain. Mr. Gordon expects to return to Honduras after a few weeks in New York City.

Brent N. Rickard, manager of the El Paso smelter of American Smelting & Refining, has been appointed chairman of the committee in charge of arrangements for the annual Western convention of the American Mining Congress. The 1930 meeting will take place in El Paso in the fall.

Rush T. Sill and **Lloyd L. Root** are president and vice-president, respectively, of the firm of Sill & Root, which has recently established offices at 115 West 7 St., Los Angeles. **Lloyd C. Nicholas** is secretary and treasurer of this mining engineering company. Mr. Sill was a member of the former firm of Sill & Sill. Mr. Root was formerly California State Mineralogist.

Clinton H. Crane, president of St. Joseph Lead, recently signed an agreement with a syndicate of New York Yacht Club members to design a defender of the America's Cup. The yacht will be 76 feet long on the water line and will, according to information recently released, carry one of the tallest rigs ever designed for a racing yacht. Before becoming a mining and metallurgical engineer, Mr. Crane had attained distinction as a naval architect, and the industries with which he is now so intimately associated will therefore follow the next America's Cup races with especial and unusual interest.

Archer E. Wheeler, of New York, has been retained by the Gipromez, the Soviet institute for designing metal works, to assist in developing the Soviet production of copper, nickel, lead, zinc, tin, magnesium, aluminum, and antimony, according to a recent announcement made by the Amtorg Trading Corporation. This new technical assistance contract involves the sending to the Soviet Union of nearly a score of American experts in various phases of non-ferrous metal production. Some of Mr. Wheeler's recent engineering achievements include the construction of the Noranda smelter, in the Rouyn district of Quebec, and the Nichols Copper refinery, now in course of erection at El Paso, Tex.

OBITUARY

W. H. Hewitson, general manager for Larut Tin Fields, Ltd., died at Taiping, Federated Malay States, recently, at the age of 54.

Dr. **John H. Leete,** dean of the school of applied science, Carnegie Institute of Technology, died on Oct. 13, at his home in Ann Arbor, Mich. Doctor Leete was 61 years of age.

Howard Vanderslice, of Kansas City, died on Oct. 10, after a short illness. Mr. Vanderslice, who was president of Lucky Tiger-Combination Gold Mining, was well known in his community as a patron of art. He was interested in several industries in addition to his connection with mining.

Jay C. McLaughlin, of Cleveland, Ohio, a partner in the firm of Pickands, Mather & Company, died on Oct. 7, after an illness of several months. Mr. McLaughlin was in charge of the pig iron department of the company. He was also a vice-president and director of Toledo Furnace, and was a director of Central Alloy Steel. Mr. McLaughlin was 55 years old.

Why Hoisting Is Safer

"IF YOU break your resolution to buy good rope, don't be surprised if something else breaks too," says a maker of wire rope. This starts a chain of thought. How good is wire rope today? Is it better than it used to be? Most other mine equipment is. Have the rope makers maintained the pace set by industry in general? Then again, how often do hoisting ropes break, and, if they do break, why? Is more attention given to selecting and installing them than formerly, and do they receive better care? Finally, these questions all merge into one resultant: Is hoisting safer today than formerly, say ten or fifteen years ago?

Taking the last question first: Hoisting accidents seem to be less common than before. Tales of skips, cages, and buckets falling because the rope has parted seem rarer than they used to be. But "seem" is not convincing. Accidents may seem rarer, yet actually be more frequent. News of them may have escaped outside attention. To decide this point one can only turn to the Bureau of Mines' statistics in the following:

Injuries From Rope Failure

Year	Coal Mining Fatal	Metal Mining Fatal	Metal Mining Injuries
1911	..	4	7
1912	..	2	6
1913	..	2	9
1914	..	2	9
1915	..	2	5
1916	0	2	5
1917	2	4	17
1918	1	3	18
1919	0	2	18
1920	0	1	7
1921	0	0	9
1922	1	3	4
1923	0	2	3
1924	1	0	4
1925	0	1	4
1926	0	1	6
1927	1	0	5

Note: the figures are of the number of men injured during the years in question. The non-fatal injuries are those which lay a man off for one day or more.

Mining accidents due to the breakage of cables in shafts and slopes, according to these figures, have shown a definite downward trend over the last two decades. In general, such accidents have been more frequent in metal than in coal mining because of the difference in working conditions. During the six-year period from 1911, when the record started, through 1916, cable failures caused 55 deaths or injuries in metal mining operations. During the seven-year period, 1921-27, only 33 such injuries occurred, almost halving the pre-war fatality rate. The large number of accidents during the Great War cannot be taken into account, because many inexperienced workers were employed to meet rush requirements, and, more particularly, because new cable was so scarce that cable companies could not guarantee delivery in less than a year.

No trend is shown by the coal-mining figures, inasmuch as the record did not start until 1916 and only fatal injuries are tabulated, the figures coming through state authorities and not directly to the Bureau, as do those from metal mines. To trace the number of accidents in which the injuries occurred is not possible, inasmuch as the Bureau lists include only "major disasters" in which five or more were killed. No such disasters are traceable to cable failures during the period of record.

Hoisting accidents undeniably therefore have decreased. Mine hoisting is correspondingly safer than it used to be. Reverting to the former questions, is this due to better rope, or better hoists, or better understanding on the part of the operator, or to all of these things combined?

Better Rope

Wire rope ought to be better than it was ten or fifteen years ago, all things considered, provided the ropes of that time left anything to be desired. Rope makers, for their part, say it is better. A wire rope engineer discussed this matter in a recent issue (*E.&M.J.* Aug. 31, 1929, p. 365). Continual improvement, insured by constant research, has been made in the quality of rope, he said. On this question the manufacturer should be better posted than the operator, unless the latter has made comparative tests, something that is unlikely, or has kept detailed record of rope in use, which is not often done. And even if records have been kept, conditions may have changed so that a comparison is difficult or impossible.

Conditions have indeed changed. While hoisting machinery has been constantly getting more powerful and in a way more efficient, the drums have been becoming smaller and smaller, which means very destructive stresses in the wire rope. Despite this, the number of hoisting accidents has decreased, indicating that better equipment is being used or better methods, or both. At the same time, one must bear in mind that straight hoisting is used to a smaller proportionate extent than formerly.

Rope breakage may be the effect and not the cause of an accident, however. "Accidents rarely occur from rope breakage or failure, but rope breakage or failure are usually due to accidents," the president of a well-known rope manufacturing company declares. In his 25 years' experience he can recall only two instances, he says, "where accidents took place as a result of rope breakage, and even in these cases it was a question whether the rope was at fault or whether some other accident had happened first. Even if the rope actually did break from overload or abuse, one must consider whether or not it had been kept in service beyond a safe limit, or in other words, too long."

Individuality

Statistics are lacking to show whether or not tonnage handled per rope has increased. If it has not, the type of machinery used, the high speed of hoisting, and the heavy loads may be held responsible for the fact. Each is very destructive to wire rope.

"In the final analysis," a Mid-Western rope engineer states, "No matter what the strength of the rope, any given wire will make only so many bends. These are limited also by the amount of weight on the wires while the bends are being made. Speed, friction, vibration are also largely destructive factors, so that a mere comparison of tonnage means nothing, not even on the same machinery with ropes succeeding one another, because no two lines are ever alike.

"At least 90 per cent of the service given by a rope depends on a human element—on the skill, judgment and knowledge of the person using it. Few people seem to realize the limitations of steel, especially steel in wire rope, which is often looked upon as a bar of iron with some mysterious property of flexibility."

Further Search

However much the quality of hoisting rope in general has been improved, the decreasing number of hoisting accidents can hardly be due to such improvement. Good rope was available ten or fifteen years ago. Poor rope may be had today. If the wrong rope for a given purpose be selected, the skill used in making it for the purpose for which it was intended may go for nothing. Wrong rope is poor rope. Other factors than improvement in the rope used must be sought to explain the fact that hoisting rope breaks less often than before.

For one thing, more is known today about the proper way to install and use rope than formerly. Manufacturers have taken pains to educate users to this end. Details once regarded as unimportant are now given proper con-

sideration. Results are greater economy and safety.

"But you cannot generalize with respect to selecting and installing wire rope," cautions a rope maker. "Asking one to do so is very much like asking a physician watching a crowd for a prescription that will be applicable to the whole assembly. He can only tell them in a general way about diet, fresh air and sunlight, and then his story is done.

"If we have a specific incline or a specific hoist, it is necessary for our engineers to diagnose the case specifically to determine what type of rope should be used, what grade of steel, what size, whether the machinery is out of true or otherwise in need of correction, and how, when, and where to lubricate. Even the work of installation will depend in a large measure at times on the arrangement of the plant."

Only the diameter of a rope registers with the workman. A case comes to mind where a mining company on changing hoisting rope substituted for a 1½-in. rope one that was actually much stronger and smaller in diameter by half an inch, whereupon the men protested at the apparent lack of consideration for their safety.

Safer Hoists

Not only is more attention given today to rope details, but hoists are safer. They have more adequate braking systems, and better safety devices are available than were possible even a few years ago. In fact, the use of such devices is so general that no progressive mining company would consider operating its hoists without employing them.

So far as safety features are concerned, there is little resemblance between hoisting equipment of today and that of 15 years ago. At that time most mine hoists were without safety devices. Some of them, it is true, had what seemed to be quite elaborate and efficient devices of this sort. In most cases, however, safety depended entirely on the skill of the hoist man. Five years later, the question of providing safety devices was at the best debatable and much effort was necessary to make a prospective purchaser see their advantages. Hoists at this time were equipped with such devices only when they were specified by the purchaser. Possibly 50 per cent of buyers would specify a device to prevent overwinding.

Sold on Safety

In the intervening years safety devices have undergone a remarkable development, paralleled by a marked change in the attitude of the operator. In fact, the doctrine of safety has been so thoroughly preached to industry in general, that a manufacturer no longer must sell a mining company the idea of safety for its hoists. Safety devices, in short, have become standard equipment.

Today the purchaser is thoroughly awake to the importance of the matter and is ready to take every precaution, practically without regard to cost. Every device that has been proved satisfactory and will make the hoist more foolproof and safe against possible accidents is readily received. Almost all purchasers specify such devices today. One salesman asserts that the companies he calls on seem glad to have them brought to their attention. Many large hoists are purely automatic as far as stopping is concerned. Once set in motion by either push button or manual operation, they can be left without an operator and will safely complete the trip and stop on reaching the top.

"We had a case about a year ago," says an important manufacturer. "The hoist man, hoisting the shift from about 2,000 ft., with the equipment set for man speed, fainted before the cage reached the collar. The hoist slowed down automatically and stopped with the cage about a foot above the collar, and the men never knew but that the hoist man himself had been instrumental in bringing the hoist to a stop."

Possibly the change that has occurred in attitude toward safety devices is owing to the fact that mine laws in practically all the states require that hoists be provided with means of preventing overwinding and overfeeding. This is enough to account for the phenomenon.

Some Aspects of Service

"SERVICE" is almost hackneyed, heard practically everywhere in industry. It means much or little, depending on the company that assumes to render it. Some manufacturers "service" their products well and at considerable cost. That this expense must be added to the cost of the product or of some other product is apparently overlooked at times by the customer when he chooses to object to prices, especially of parts.

Servicing a machine following a sale is not the only kind of service. Service often precedes a sale—something that also may escape the customer's attention. The work of preparing designs and estimates, preparatory to submitting bids, may appear but part of the preliminaries of getting business and chargeable as such, but to the customer, mentally in the woods, perhaps, as to how to solve an equipment or a process problem, it is a service that may turn out to be a life-saver.

Another Slant

Such service assumes another aspect when one considers that several manufacturers may be competing for the business, each one doing his bit of thinking for the customer, although only one of them will win. In this the customer enjoys a great advantage, not necessarily a buyer's right, in the wealth of consultation that descends upon him.

Occasionally things take a peculiar twist, when complaint is heard that a prospect has declined all bids and used drawings and calculations furnished as a basis either for manufacture in his own shop or for seeking other bids elsewhere at lower prices. Naturally, lower bids are possible where no such preliminary expense has been incurred. The ethics of such procedure are questionable. Proper appreciation of the service as a service might have caused the company seeking bids to pursue a different course.

Still another service is of the kind performed by a leading electrical manufacturer in maintaining a school of welding. Immediately the cynic exclaims, "Mere advertising!" calling it a trick to create prejudice in favor of the company's welding products. Such service cannot help but advertise, but the fact remains that the course offered is thorough, practical, and probably unsurpassed, if equaled, elsewhere. To date more than 900 men, representing every state and several foreign countries, have attended it. As a trade school it is efficient. As a service to industry it is hard to beat. To this school the operator lacking competent welders may send apprentices, or anyone may go as a student. Here, without charge for tuition, but otherwise at their own expense, these neophytes are expected to remain until they have completed the required course, which on the average takes three months. On "graduation" they receive a certificate of proficiency. Naturally, the electrical company cannot guarantee employment and they must hunt for jobs unless they have made connections previously. Such a scheme is doubly advantageous to the operator, not only in maintaining a school where green men may be trained, but also in providing a floating supply of craftsmen on which he may draw if necessary.

Service may have a string to it, either in that its cost must be returned somehow or that the company offering it benefits indirectly through the "gift." But those receiving it should ask where they would be without it. The quality of service or the lack of it should be carefully considered on making selection of equipment.

A Maze

Simplification is needed in the lubricant industry. Confronting a prospective purchaser is a large number of refineries, each producing many different lubricants. Collectively these present a confusing array from which to choose. Were it not for the not-disinterested services of the lubrication salesman, the average operator would be in a quandary as to what he should use. Many of these brands could undoubtedly be correlated with one another within certain limits and the correlation indicated by some scheme of classification.

A. H. H.

NEWS OF THE WEEK

Summary

AN INCREASE in the output of eastern British Columbia is expected to result from the larger tonnage that will be handled at the Sullivan plant and the several new concentrators that will start operations within a few weeks. Base Metals is the most important new development. Page 638.

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Lake George Metals has started operation of the pilot plant at its property at Captain's Flat, New South Wales. Ore reserves doubled within the last year and a half. Page 637.

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Developments at depth in the Lake Shore mine, at Kirkland Lake, Ont., continue to be favorable. Adverse rumors about Kirkland Lake mines are not affecting the expansion program of the company. Page 640.

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Santa Gertrudis has adopted an extensive two-year program at its properties in the Pachuca district of Hidalgo, Mexico. Exploration work will be undertaken at greater depths in the Dos Carlos mine. Page 637.

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Tri-State Zinc and Lead Ore Producers' Association has endorsed the stand of the American Zinc Institute on a tariff for all imported zinc ores containing less than 10 per cent zinc. Page 641.

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Development of the orebody struck on its 2,550 level is reported on the 2,250 level of the Magma Copper property, at Superior, Ariz. Page 640.

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A sharp decrease is reported by the U. S. Bureau of Mines in both death and injury rates in the United States mines during 1928, as compared with the record for 1927. Page 636.

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Exclusive rights over a large area of Queensland government land containing lead-zinc deposits have been obtained by Mining Trust. Page 637.

San Francisco A.I.M.E. Meeting Proves Interesting and Entertaining

Well-Attended Sessions Hear Many Pertinent Papers on Problems of Both Metallic and Non-Metallic Mining and Milling —Quicksilver Meeting an Unusual Feature

G. J. YOUNG

ERNEST A. HERSAM introduced President F. W. Bradley at the opening meeting, on Oct. 7, to the members and friends who attended the 138th meeting of the American Institute of Mining and Metallurgical Engineers. This was the fifth meeting held in San Francisco. President Bradley welcomed the members, who, together with their wives, totaled over 400, and read a telegram of greeting from Secretary Bain, unavoidably absent from the meeting. Theodore J. Hoover was introduced and read a message of welcome from Secretary Ray Lyman Wilbur of the Interior Department.

Mining problems of the West were discussed by Charles W. Merrill, another distinguished member. Mr. Merrill spoke of the overproduction of certain mineral commodities, revision of existing mining laws, the need for increased gold production, the advantage of international agreements covering the production of certain minerals, the necessity for a widespread understanding of the basic nature of mining, and the means for stimulating exploration for ores and non-metallic minerals.

With Harvey S. Mudd in the chair, the afternoon started with the reading of a carefully prepared paper on "Governmental Control of the Production and Control of Mineral Resources," by William E. Colby, of San Francisco. Mr. Colby has long been a student of mining law and the civil contacts of the mining industry. He pointed out in his conclusion that governmental control is inevitable and the necessity for governmental control is increasing daily.

In the ensuing discussion Mr. Merrill expressed the opinion that prospecting would be still further handicapped if it had to deal with state bureaucracy instead of one federal bureau when it became necessary to determine whether the surface rights of the state or the subsurface rights of the nation would prevail. T. A. Rickard joined in the discussion.

Frank M. Smith brought news of the Spokane meeting. A "Symposium on Our Mineral Resources" was introduced by Dr. George Otis Smith, director of the U. S. Geological Survey, who discussed coal. C. K. Leith spoke on "Iron Resources of the World," and Dean Frank H. Probert, of the mining department of the University of California, at Berkeley, closed this interesting subject with a brief review of the importance of the coming International Engineering Congress in Japan. He stressed the part to be played as a means to promote world peace.

On Monday evening President and Mrs. F. W. Bradley were hosts at a delightful banquet. Geniality and cordiality featured the occasion. President Bradley piloted his own ship. Significant was the presentation of Institute medals to four members who, after 50 years of membership in the Institute, are active and who received the recognition of the members of the Institute in person. They were James W. Neill, of Pasadena, Calif.; Henry D. Hibbard, of Plainfield, N. J.; W. H. Radford, of San Francisco; and Robert H. Richards, of Cambridge, Mass. President Bradley introduced each and made the presentation. Charles E. Locke, of Cambridge, made a brief address. Mrs. T. A. Rickard entertained with her delightful songs and Prof. W. S. Weeks roused merriment by his "Two Portal Bill" poem. T. A. Rickard made the closing address, which included glowing praise for President and Mrs. Bradley.

THE MINING MEETING

Theodore J. Hoover and W. S. Boyd were joint chairmen of the technical mining meeting on Tuesday.

"Barite in California" was the subject of a paper presented by W. W. Bradley, state mineralogist of California. Mr. Bradley dissected this subject from the production, occurrence, and utilization angles and then told about specific deposits in California. The paper was informative. O. M. Tupper, who is superintendent of the Clay Corporation of California, at Lincoln, Calif., described the fine grinding of fireclays of comparatively high moisture content in a Raymond mill unit equipped for the

exhaustion of the ground product by a fan, and its separation from the return air by a cyclone collector. The effect of different types of clay in respect to tons ground per hour was discussed briefly. Mr. Tupper stated that this type of impact mill proved economical in labor, cost, supplies, and repairs.

"The Origin and Occurrence of Southern California Tertiary Clays" was presented by Robert Linton, who is now interested in the clay industry. Mr. Linton's paper represents an inquiry into clay deposits and is a useful contribution to the subject. A general discussion of "Bentonite and Related Clay Minerals in the Southwestern States," by Frank R. Wickes, of Los Angeles, was read by Prof. J. A. Carpenter.

A paper by W. B. Tucker, of the California State Mining Bureau, on the work of that bureau in non-metallics in southern California, was read by George J. Young in the absence of the author. This paper pointed out the valuable opportunities and sources of information available. A short general discussion closed the morning's session. A feature of this discussion was the appeal made by Dean Probert for the interest of mining men in the non-metallic field.

At the Afternoon Session

T. A. Rickard and Jay A. Carpenter were joint chairmen at the afternoon session. Mr. Rickard is the veteran editor of mining publications and Mr. Carpenter a young mining professor. A symposium of mining methods proved interesting. W. S. Boyd confined himself to underground caving, graphically describing the features of this important method. Mr. Boyd stated that there are no caves in the undercut caving method, as particular care is taken to see that no large voids occur and that the cap rock is brought down upon the moving ore as it is drawn out. Subsidence or settling goes right through the capping. He also stated that undercut caving is the safest known method of extracting ore. He quoted statistics about the various methods, and when tonnages per man are taken into account the validity of his assertion was proved. Illustrating with his hands the outlines of ore mass and capping, he described the general features of the method, stating that all applications were the same in principle but different in details. He pointed out that chutes draw only ore vertically above, and that it is therefore necessary to place the chutes or draw points as closely as possible together. The four sides of a block of ore are weakened either partly or wholly. Details of the methods depend upon the character of the ore mass and capping.

E. D. Gardner, of the Bureau of Mines, summarized Fred W. Snow's paper on the "Mining Methods and Costs at the Magma Mine." This is an exhaustive paper and is available in mimeographed form. W. I. Nelson described the methods in use at the Engels copper property, in California, where pillars dividing shrinkage stopes are diamond drilled and blasted when the stopes are finally emptied. He stated that open spaces are left in some instances 750 ft. long and 250 ft. high, but such is the strength of the ground that after a week or more, during which sloughing takes place, no further ground movement occurs. A. C. Stoddard's paper on the "Methods at Inspiration" was read by title in the absence of the author.

"The History of Mining Methods in Use at the Alaska Juneau Mine" was presented by Philip R. Bradley. Mr. Bradley said:

"The problem at the Alaska Juneau mine in 1917 was to select a method of mining in an orebody of about $1 per ton with an assumed milling cost of some 20c. per ton and at the same time to leave a margin of profit within these limits. Physical conditions of the orebody were known by the results of earlier mining methods. The orebody is inclined at 60 deg. from the horizontal, and it was decided to take full advantage of known fault planes which intersected parts of the orebody. The method adopted included the undercutting of large areas and the driving of raises through to the levels above, and from these raises crosscuts or coyote holes were extended. These were loaded and blasted to force the caving of the orebody. Cutting out started at a vertical height of 50 ft. above the haulage level and the floor was cut at the angle of flow. Pillars were left where the back was weak. Stopes 250 ft. wide and 750 ft. long were first tried and later were reduced to 250 ft. square."

Much interesting detail was given by Mr. Bradley, who pointed out some difference of the Juneau method as compared with the undercut caving system.

Conditions at North Star

Arthur B. Foote described conditions at the North Star mine, at Grass Valley. At this property production had overtaken development to such an extent that it was necessary to initiate a major development plan while still keeping the property in production. The main vertical shaft was deepened 2,000 ft. and two inclines were sunk on separate veins.

W. S. Weeks, of the University of California, gave variety to the meeting by discussing "The Theory of Cooling." This paper covered a dissection of ideas upon the Kata thermometer, mathematical equations, and an illuminating explanation of body evaporation. James C. Ray, of Stanford University, balanced up the other side of the mining meeting by presenting a paper upon "The Age and Structure of the Butte Vein Systems." He illustrated his theories by a model which showed in a striking fashion the complex intersecting vein system so familiar to students of the Butte district.

No mining meeting is complete without something about geophysics. Sufficient talent was available to have used up the remainder of the day, but the firm-jawed chairman restricted the last speaker to only the remnant of time remaining. Eugene A. Lockton presented a paper on "Magnetic Measurements on Placer Deposits." He illustrated a series of magnetometer measurements taken upon certain placer areas wherein sufficient magnetite occurred to enable measurements of horizontal and vertical intensity to be made. Mr. Lockton referred to previous work done in the same department of research. He expressed the opinion that where local concentrations of magnetite featured a placer deposit, magnetometer measurements offer interesting possibilities.

Mr. Rickard, in closing the session, commented upon the excellence of the presentation made by the speakers and highly complimented W. S. Boyd for his clear explanation of the subject of undercut caving.

The Milling Section

Charles E. Locke presided at the milling meeting. Great interest was taken and the room was filled. John Gross, of the Bureau of Mines, presented two papers in abstract—one on the relation of measured surface of crushed quartz to sieve sizes, and the other on the relation of work input to surface produced in crushing quartz. Both papers were written by John Gross and S. R. Zimmerley. Mr. Gross stated that much of the work in crushing and grinding is expended in producing finer material than is required and that by measurement of surface of the crushed material an index of the useful work can be obtained. He also said that in crushing quartz the new surface produced is in direct proportion to the work input in accordance with the Rittinger law of crushing.

Microscopic study of the mill products of the Utah copper concentrating mills was discussed by H. S. Martin. Many operating companies are now taking advantage of thorough studies of their operations and have resorted to the use of the microscope. Mr. Martin's paper is an excellent example of what can be accomplished in a better understanding of mill work generally.

W. L. Pennick read a paper on "Crushing and Grinding," by Harlowe Hardinge. Mr. Hardinge brought out the point that ball-mill feed is now on a ¼-in. basis, and finer grinding than hitherto practiced is the order of the day. Increased circulating loads have also resulted. He said also that larger grinding units are indicated. W. H. Coghill discussed the paper on "Differential Grinding Applied to Tailings Re-treatment," presented by L. M. Banks and G. A. Johnson, of Joplin, Mo. Both authors were absent.

"The Importance of Classification in Fine Grinding" was presented in abstract by J. V. N. Dorr and the flow sheets were explained by A. D. Marriott, co-author with Mr. Dorr, from lantern slides. The important point brought out by Mr. Dorr and Mr. Marriott is that more thorough classification, or the bypassing of finished sizes in fine grinding, can be accomplished and will be an important factor in increasing grinding efficiency.

Charles Butters and Rudolph Gahl were chairmen at the afternoon session. Mr. Butters introduced Don Carlos F. de Landero, who was long associated with the Real del Monte Mines, in Mex-

ico, and is an Institute member of some 23 years' standing.

E. S. Leaver and J. A. Woolf presented a paper on "The Effect of Copper and Zinc in Cyanidation," in which they discussed sulphide-acid precipitation. Oliver C. Ralston summarized three papers on details of flotation, one having to do with the activation of sphalerite, one on "Reducing and Oxidizing Agents and Lime Pulp," and the other on "Copper Sulphate as a Flotation Activator for Sphalerite." These interesting results of research were commented upon by Charles E. Locke, who said that the authors had succeeded in translating flotation and had presented an intelligent basis for understanding what flotation really is. He congratulated the several authors of the papers on the work done. Rudolph Gahl stated that hitherto the development of flotation theory had been done at the universities, but now the mining companies are making substantial contributions to this obscure question. Oliver C. Ralston stated that the results of these papers were really by-products of a carefully designed research for commercial applications of flotation.

Charles Butters read by title C. W. Lawr's paper on "Cyanide Regeneration" and expressed the opinion that it was a valuable contribution on the subject. W. H. Coghill then presented a paper, "Laboratory Investigations on Ball Milling," by A. M. Gow, A. B. Campbell, and W. H. Coghill. Much discussion resulted. H. W. Hardinge stated that he had never been inside of a ball mill in action, but he felt that the diameter and consequent peripheral speed should be commensurate with the size of the ball used. Smaller balls require less peripheral speed and vice versa. O. H. Johnson said that 8-ft. ball mills had been installed at Inspiration and that the mill capacity increased as the liners wore down. This indicated a greater grinding effect with larger diameters. This conclusion, he stated, was checked at the Andes copper property, where 9x9-ft. mills were installed, resulting in 25 per cent greater capacity, and now 10-ft. mills are contemplated. W. L. Pennick said that two 8-ft. and 10-ft. mills were installed at the Consolidated mill, Kimberly, B. C., where each size occupied the same floor space, but the larger mill showed 14 per cent increase in efficiency. Similar results had been found at other places.

E. L. Oliver said that the remarks upon critical speed were borne out in practice and called attention to the comparatively minor rôle played by impact. In his opinion attrition plays the major part in grinding. W. H. Coghill questioned the beneficial results of roller bearings. O. H. Johnson in reply stated that one type of roller bearing gave better starting torque, but was beneficial only during acceleration. H. S. Martin stated that there was no power saving on mills equipped with roller bearings at the Utah Copper plant.

The interest in quicksilver mining in Western mining states found expression in a special meeting devoted to this subject. August Locke and Robert Linton presided. C. N. Schuette presented a paper on "The Geology of Quicksilver Deposits." He said that most deposits in California occur in broken masses along the contact line where peridotite has penetrated Franciscan cherts and shales. Concentrations of ore are found where deformation produced voids in which were collected the mercury minerals. August Locke and C. L. Gillan discussed the paper. A. V. Udell presented a paper on "The Use and Usefulness of Mercury," wherein he outlined a number of new developments dependent upon the use of mercury. He stated that domestic demand requires annually about 30,000 flasks, of which from 11,000 to 15,000 flasks are produced from domestic sources.

L. H. Duschak spoke about "Improvements in the Metallurgy of Quicksilver," in which he called attention to the use of the Cottrell apparatus in the condensing system. Discussion brought out the opinion that the quicksilver supply would be insufficient if a widespread use of quicksilver for power purposes were to eventuate. However, it was conceded that the United States has available sufficient mercury resources in case of war, provided that full use is made of substitutes.

Bay Excursion

An all-day trip on San Francisco Bay brought members and guests together on Wednesday. A better day could not have been had. Members and others returned refreshed, and then departed to their hotels and homes, returning to a dinner and evening of entertainment held at the St. Francis Yacht Club. Speeches were taboo. Good fellowship prevailed. The entertainment pleased, and everyone expressed satisfaction.

Thursday afternoon brought many to the bayside, where the "President Jackson" and "Korea Maru" sailed to Japan with the engineers who are to attend the International Engineering Congress.

Fatality Rate in Mining Dropped 19 Per Cent in 1928

DURING 1928, 273 men were killed and 22,483 injured in metal and non-metallic mines in the United States, according to the U. S. Bureau of Mines. Fatality and injury rates were 2.50 and 205.62 per 1,000 workers on the basis of 300 shifts a year. Fatality rate was 19 per cent and injury rate 7 per cent below the 1927 figures. In mining, 113,866 men were employed in 1928, 5,833 fewer than in 1927.

Of the total, 70,188 workers were employed underground, 29,378 on the surface, and 14,300 in open pits. Deaths numbered 227 underground, 31 on the surface, and 15 in open pits. The accompanying table shows the death rate for the several branches of the mining industry:

Product	Number of Men Employed	Number of Operators	Deaths per 1,000 Workers
Copper	30,561	213	3.03
Gold and miscellaneous	31,622	2,196	2.60
Iron	29,145	99	2.16
Lead-zinc (a)	10,334	85	1.62
Non-metallics	12,204	249	2.13

(a) Lead-zinc mines in Mississippi Valley only; others under gold and miscellaneous.

Seneca Increasing Output

Production at Seneca Copper, operating in the Michigan copper district, is at the rate of about 1,000 tons daily, of which 700 tons is mill-grade ore. Crosscutting to the vein at the 10 level is under way in No. 1 shaft. The shaft will be sunk to the 11 level after drifting is started in the lode. The 25 level of No. 2 shaft, which is the extension of the 3 level of No. 1 shaft, is being driven north of No. 2 into virgin territory. This pioneering work to the north is also important to Ojibway, as the drift is being extended toward that property. Seneca and Ojibway are largely held by the same interests.

King Loses Claim in Lucky Boy Mill Suit

CLAIMS by C. W. King that Hawthorne Mines, Inc., operating a property at Hawthorne, Nev., owed him $46,247.44 were set aside in a decision by Judge J. E. Walsh. About two years ago the mining company, which leases a portion of its ground from Lucky Boy Consolidated, contracted with Mr. King for construction of a mill. He was to obtain 75 per cent of the net returns of the mill, which was to mill ore only from Lucky Boy ground, in return for constructing the plant. Under these terms $25,767.71 was paid when the mine closed down, of a total price of $72,000. Mr. King then entered suit for the balance which he claimed to be due him.

Judge Walsh pointed out that the plaintiff was aware that only Lucky Boy ore was to be treated, that the contract clearly stated his payment was to come from net returns, and that he should have considered the life of the mine in constructing a mill to cost $72,000. Since suspension of operations, Hawthorne Mines and Lucky Boy have consolidated. The mill will be put in commission within a short time, according to reports, and payments to King will be resumed on the contract basis.

Lagares Mill Started

Operation of the 100-ton mill recently constructed by Lagares Tin at its properties in the Province of Beira Alta, Portugal, has been started, and regular shipments of concentrate are being made. This company is a subsidiary of Camp Bird, Ltd., and was formed in 1927. The properties are about 20 miles from Viseu, on the Val de Vouga railroad, and have a total extent of 10 square miles.

Lake George Starts Pilot Plant Operations

OPERATION of the pilot plant at the Lake George Metal Corporation's property, Captain's Flat, New South Wales, Australia, has been started, according to Camp Bird, Ltd., which has a controlling interest in the company. This plant has a capacity of about 1,000 tons of ore a month, and will be used to determine the flow sheet of the large plant, with a probable capacity of 500 tons daily, that will be built at the mine. T. C. Baker, general manager of the Fresnillo mine of the Mexican Corporation, another Camp Bird subsidiary, is now on his way to New South Wales to design the mining and milling plants.

Recent developments by diamond drilling continue to show good results. A new drill hole in the central section of the mine, hitherto unprospected, has cut a vein at a depth of 470 ft. At this point it is 13 ft. 6 in. wide. The 9 ft. of core recovered averaged 12 per cent lead, 20 per cent zinc, and 0.5 per cent copper. Total reserves of proved and probable ore are about 2,000,000 tons, averaging about 20 per cent combined lead-zinc. Silver content averages about 1.5 oz. per ton; gold, 1.3 dwt.; and copper, about 0.7 per cent.

Originally this property, first opened in 1882, was operated as a gold mine and later as a low-grade copper property. It failed to pay, however, and as the lead-zinc deposits found at depth were junore, because of the impossibility of effective metallurgy, the mines had to be abandoned in 1899. Construction of a railroad from Bungendore, 25 miles away, was considered by the government in 1897, but reports by J. B. Jacquet, of the mines department, were unfavorable.

In 1926, a syndicate representing National Mining and Camp Bird acquired the property and F. J. Thomas was placed in charge of exploration work. After eighteen months Mr. Thomas reported that results justified construction of a large concentrator. Up to this time, about 6,000 ft. of underground development had been done, showing total reserves of about 1,000,000 tons, including the results of drilling. Since then they have been practically doubled by additional work.

The Lake George Metal Corporation was registered in London with a capital of £1,000,000 to acquire this property early in the year.

Basin Montana Strikes Vein

Basin Montana Development at Basin, Mont., in exploring its south Comet vein from the 400 level, has driven over 100 ft., according to Samuel Barker, Jr., managing director. At the 40-ft. point a vein of silver-lead-zinc ore was opened and at the 72-ft. point an offshoot to the south showed high-grade ore. The drift is being driven nearly due east and the face is in 5 ft. of quartz.

Park Utah Team Wins Shoveling Contest

THE shoveling contest held at the Utah State Fair, in Salt Lake City, on Oct. 7-12, was won by the team from Park Utah Consolidated, consisting of Sam Williams and Joe Quintana. They were awarded $150 in silver dollars by A. C. Moore, of the mining committee of the Salt Lake City Chamber of Commerce. Ardell Beckstead and James Foreman, of the Lark unit of the United States Mines, won the second prize of $100. Tintic Standard's representatives, Oscar Ziklund and Eric Anderson, won third prize of $50.

The winning team shoveled a ton of lead ore from a concrete floor into a Mattson mine car in 1 min. 12 sec. The car was set on a Fairbanks-Morse scale with tare, and three judges with stop watches timed the event. The second team shoveled a ton in 1 min. 14⅘ sec. and the third team in 1 min. 15 sec. Meyer short D-handle square-point shovels were used by all contestants.

Santa Gertrudis to Develop Dos Carlos at Depth

DEVELOPMENT of the Dos Carlos mine, in the Pachuca district, Hidalgo, Mexico, at greater depth is part of a two-year program adopted by directors of Santa Gertrudis at a recent meeting held in London. Hugh Rose, managing director of the Mexican properties, was present at this meeting. Work on sinking to the No. 23 level and opening up the vein at that depth have already been started. Developments on the Nos. 19, 20, and 22 levels have been better than expected. An important part of the program will be exploratory work south and east of the Dos Carlos mine and north of the Ohio area, which are regarded as the more promising sections of the property. Drifting in the western end of the property will be continued.

On No. 19 level, the west drift had been advanced 315 ft. on Sept. 25. The first 256 ft. was in ore averaging 1.50 dwt. of gold and 20.50 oz. of silver per ton. The last 59 ft. was junore. The west drift at No. 20 level was advanced 197 ft. in ore averaging 4.15 dwt. of gold and 48 oz. of silver per ton. This was followed by 131 ft. of junore and then 131 ft. of ore averaging 3.85 dwt. of gold and 43 oz. of silver per ton. An additional 79 ft. of junore had been drifted on up to Sept. 25. On the No. 22 level, the west drift showed 272 ft. of ore, averaging 2.90 dwt. of gold and 32 oz. of silver per ton. Average width of the vein on the three levels is 10 ft. As soon as new equipment is installed, a drift west on the No. 21 level will be started.

Mining Trust Obtains Concession in Queensland

EXCLUSIVE concession of rights over a large area of government land containing lead and zinc ores has been granted to Mining Trust, Ltd., by the Queensland Parliament. Mining Trust has also acquired under option an additional large area in which the existence of these ores is definitely proved. Mineral occurrences on both areas are reported to be analogous to the Mount Isa deposits, which Mining Trust controls.

Foundations for mill buildings were completed about the middle of September at the Mount Isa property, according to recent reports from the company, and erection of steel work on the plant, which will handle a minimum of 2,000 tons daily, has been started.

[The general elections in Australia, held on Oct. 12, resulted in a sweeping victory for the Australian Labor party. What effect this will have on mining operations in that continent, if any, is awaited with interest. The Nationalist party still controls the Australian Senate, so that no drastic changes are expected.—The Editor.]

Consolidated M. & S. Options Kinman Property

Consolidated Mining & Smelting has completed negotiations for an option on a controlling interest in the Kinman property, near Nimpkish Lake, at the northern end of Vancouver Island, British Columbia. The company has started to build a road from the lake to the property, and to build a camp. As soon as this work has been done, a power plant, compressor, and diamond drill will be taken to the property and exploration will be pushed by both drilling and underground work.

C. & H. Stops Work for Season at Calumet Dam

Dredging of the Calumet dam in the Michigan copper district by Calumet & Hecla has been discontinued for the third season. About 100,000 tons of tailing, averaging about 35 lb. of copper per ton, has been recovered from the bank deposited here by the original Calumet mill in 1867-70. The old tailing is almost twice as rich in copper as the ore now mined.

Supreme Court Denies Silver Case Review

A review of the suit of the American Silver Producers' Association against the U. S. Treasury has been denied by the U. S. Supreme Court. The producers held that the U. S. Treasury was compelled to purchase about 15,000,000 oz. at $1 an ounce, under the provisions of the Pittman Act. Lower courts had rendered unfavorable decisions.

Expect Increase in Metal Output of Eastern British Columbia

Enlargement of Sullivan Concentrator and Construction of Several New Plants Should Swell Total—Base Metals Most Important Property Under Development in the Section

F. H. Mason
Special Victoria Correspondent

PRODUCTION from the mines of southeastern British Columbia, in what is generally known as the Kootenay district, is expected to show an increase in 1929 over the output in 1928, when it produced $27,971,027 of a total production of $48,425,033 in metals for the entire province. Most of this output—all but $2,000,000 in fact—was handled by the Sullivan and St. Eugene plants of Consolidated Mining & Smelting. The increase in the capacity of the Sullivan concentrator to 6,000 tons daily should therefore be the most important factor in swelling this area's production, although the starting of operations at several new plants will undoubtedly play a part in the increase.

At the St. Eugene plant, which has a capacity of 800 tons daily, Consolidated Mining & Smelting has been treating a mixture of the tailing from the old St. Eugene mill and ore from the dumps of the Sullivan mine that has become oxidized by exposure to air and therefore requires a different treatment than the ordinary run-of-mine ore. During the winter when Moyie Lake, in which the St. Eugene tailing is cached, is frozen, only Sullivan-dump ore is treated. An interesting feature of the treatment is that although practically no gold was recovered in the original treatment of St. Eugene ore, the plant has extracted an appreciable amount in treating the tailing. This deposit is almost exhausted, and the probability is that with the end of the present season the St. Eugene mill will be used exclusively for the Sullivan ore and such custom ores as may be provided by other mines.

At the Sullivan mill, which operated last year on the basis of 4,000 tons daily, about 5,000 tons is now being handled. By the time this article is published, this figure may be raised to 6,000 tons, which will hereafter be capacity. Production, however, will not show as large an increase as the higher tonnage would indicate, as a great deal of low-grade ore will be treated. Consolidated gives no specific information as to ore reserves in any of its mines, but officials have stated that the ore developed and indicated by diamond drilling at the Sullivan mine is sufficient to maintain the mill in operation at its present capacity for 30 to 50 years. The limits of the orebody have not yet been determined.

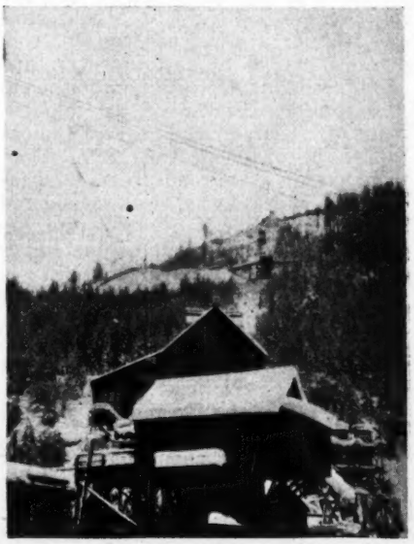
To date, about 9,500,000 tons of ore has been extracted from the Sullivan mine. The cost of mining has been reduced to about 25c. a ton. Average grade is about 21 per cent combined metal content, with zinc content slightly higher than lead. The deposit ranges from 150 to 240 ft. in width and up to 800 ft. in length.

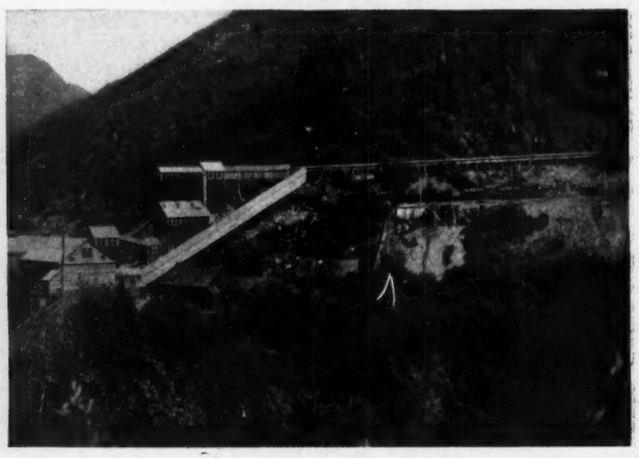
Though as yet it has no record of production, Base Metals Mines, operating at Field, will soon be the largest independent operator in the district. The company's new mill is expected to go into operation early in November. The coarse-crushing plant will have a capacity of 450 tons of ore daily, but the flotation unit is built on the basis of 300 tons daily. However, preparations are being made to permit increasing capacity to 450 tons as soon as development warrants. Two 420-hp. Fairbanks-Morse Diesel engines have been installed in the power plant. Foundations have been set for a third unit if and when mill capacity is increased.

In its Monarch and Kicking Horse mines, the company has developed about 400,000 tons of ore, carrying about 2 oz. of silver and from 20 to 35 per cent combined lead and zinc. Development work has been limited by the power available, so that large increases in the total reserves are expected.

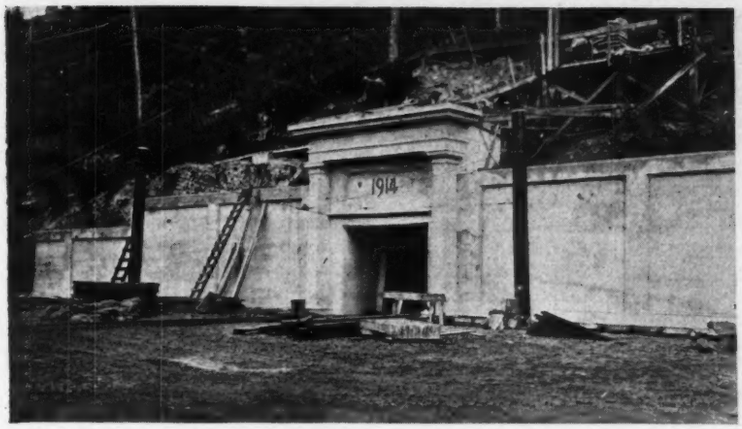
Slocan Silver Mines, controlled by Standard Silver Lead Mining, operating the McAllister mine, at Three Forks, is one of the largest independent shippers to the Trail smelter of Consolidated Mining & Smelting. About 350 tons of ore is being sent weekly, as compared with a total of only 2,270 tons sent in 1928. The ore carries about 39 oz. of silver a ton and gets a special smelting rate of $1.50 a ton because of its fluxing properties.

Operation of the Lucky Jim mill, at Zincton, will probably be resumed early in November. This property, which is controlled by the Victoria Syndicate, of London, carries oreshoots which occur as unrelated replacement deposits in limestone. The only way to determine the contents of these shoots is to mine them out. This was done so effectively early in the year that the mill had to be closed, although shipments in 1923 totaled more than 4,400 tons of concen-





Three small mills in the Kootenay district —the Noble Five plant at the lower left, the Lucky Jim concentrator in the lower right, and the Ruth Hope mill at the upper right



The entrance to the Sullivan tunnel of Consolidated Mining & Smelting at Kimberly

trate. However, a new shoot about 240 ft. long was found recently between levels 5 and 6.

In an extension of the Silversmith lode at Sandon the Ruth Hope mine has opened up a fairly large tonnage of silver-lead-zinc ore. At present the mill is treating about 50 tons daily, carrying 25 oz. of silver, 6 per cent lead, and 6½ per cent zinc. Some clean galena is being shipped direct to the smelter.

Production from the Noble Five group, also at Sandon, was only started early this year. When the company now operating the mine acquired it, about two years ago, a vigorous campaign of development was started 800 ft. below the old workings on the dip of the vein. An oreshoot ranging from 6 to 20 ft. in width has been exposed for 350 ft. on the Deadman vein. The company is producing from the 1,800 level and developing the shoot on the 1,600 level. Virgin ground exists from this point to the old workings, 600 ft. above. The Noble Five vein is being developed on the 700 and 800 levels. A crosscut is being driven to open the Surprise vein at greater depth. From the upper workings of this vein, 48,360 tons, averaging 47 oz. of silver to the ton, 18 per cent lead, and 13 per cent zinc, was produced.

The mine is connected by a 1½-mile cable tramway with the 100-ton mill at Cody. Owing to water shortage, the plant is now handling only 80 tons daily. This tonnage will have to be reduced during the winter, when the water shortage is more acute. Feed going to the mill averages 18.9 oz. silver to the ton, 8 per cent lead and 9 per cent zinc. About 240 tons of lead concentrate and 260 tons of zinc concentrate are being shipped monthly.

Galena Farm Consolidated Mines is a consolidation of the Galena Farm, Hewitt, Hazard, Noonday, Metallic, and Lake Shore properties that was arranged largely by the Victoria Syndicate. Galena Farm and Hewitt are old mines with notable production records. In 1928, Galena Farm mined 7,938 tons, and Hewitt produced 14,177 tons. Consolidation of the properties gives the company about 2½ miles of territory on the shear zone from which the Galena Farm and Hewitt production has come. A new flotation mill, with a capacity of 100 to 150 tons, has been built on the shore of Slocan Lake. A deep-level main haulage adit is being driven, from which all the properties ultimately will be worked. The new mill is expected to go into operation before the end of this month.

Whitewater Mines, at Retallack, which produced 24,555 tons in 1928, labored under the difficulty of insufficient capital, and production was made at a slight operating loss. At the company's annual general meeting a statement was made that reconstruction and consolidation with neighboring properties were under consideration. Shipments of concentrate are being made to Trail from the 150-ton mill. They average about 75 tons weekly.

For more than two years Western Exploration has been developing the Mammoth group, adjoining the old Standard mine, which the company has also acquired. A continuous shoot of ore has been opened in seven levels and connecting raises, for 1,200 ft. on the dip of the vein. The vein ranges from 2 to 20 ft. in width. During 1928 the company shipped a small amount of development ore. It is now constructing a 100-ton mill on the shore of Slocan Lake, a 16,000-ft. cable tramway to connect the mine and mill, and a hydro-electric plant, which is expected to provide ample power for continuous operation during normal seasons. The company expects to have the plant in operation in November. When the Mammoth is producing, the company will explore the old Standard at greater depth.

Cork-Province Mines has developed the old Cork-Province mine, at Keen Creek, to greater depth, and equipped it with a 150-ton mill and hydro-electric plant. The plant is now one of the largest contributors of lead and zinc concentrates to the Tadanac smelter. A shoot of mill-grade ore, 4 ft. wide and 140 ft. long, has been developed between No. 5 and No. 6 levels, giving a depth of 125 ft., with ore above and below. Several smaller blocks of ore have been developed in other parts of the mine. During the last ten days of September the company shipped 227 tons of lead and zinc concentrate.

Active development is under way at the Bluebell, at Riondel; the Yankee Girl, at Ymir; the Kootenay Florence, at Ainsworth; and the Reeves-McDonald and Red Bird, at the Pend Oreille River, near the international boundary; but considerable development will have to be done at these mines before they are brought to regular production. More than 2,000,000 tons of low-grade zinc-lead ore has been indicated at the Reeves-McDonald mine.

Since the beginning of the year to the end of September, 418,103 tons of concentrates and ores had been received at the Tadanac smelter, 395,803 tons of which came from Consolidated Mining & Smelting mines.

The metal production for the same period was 12,054 oz. of gold, 5,402,297 oz. of silver, 110,345 tons of lead, 66,689 tons of zinc, 1,024 tons of copper, about 375 tons of cadmium, 10 tons of bismuth, and a small amount of palladium and platinum.

Clara Swansea to Continue Exploration

SETTLEMENT of back taxes due on the Clara Swansea property, in the Bouse district, near Yuma, Ariz., was made recently when O. M. Souden, president of the company, reached an agreement with the county board of supervisors. The board accepted $4,500 for the delinquency, with the provision that the 1929 taxes be paid. Souden explained that a working agreement with American Smelting, Refining & Mining, whereby that organization would develop the property, hinged on the settlement of the back taxes. Mr. Souden informed the supervisors that the owners have spent $300,000 in the last two years on development work, that he was forced to obtain a personal loan to meet the tax settlement, and that unless the board could meet his terms it would be necessary to abandon the property entirely. Thirty men are now employed at the property to carry on exploration work. The tax settlement made with Mr. Souden by the board amounted to approximately one-third of the taxes due on the property.

Capacity of Russian Mines to Be Greatly Increased

ACCORDING to the program recently adopted by the Council of People's Commissars, of the U. S. S. R., a greatly increased production of non-ferrous metals is planned. Copper production by 1933 will be at the rate of 150,000 tons annually, instead of 32,000 tons produced last year, if this program is completed on schedule time. Production of zinc, which has been about 4,000 tons annually, will be increased 40 times, and of lead, which has been about 2,000 tons annually, 60 times. A. E. Wheeler, American metallurgical engineer, will be in charge of this program of expansion, which will include construction of new smelters in the Siberian and Far Eastern regions as well as the Kazak, Uzbek, and Transcaucasian republics.

Lake Shore Strikes Rich Stringer at 2,000 Ft.

A RICH stringer, 18 in. wide, has been struck in the west drift on No. 2 vein at the 2,000 level of the Lake Shore mine, at Kirkland Lake, Ont. It had been drifted on for 50 ft., at the most recent report. The vein, where crosscut opposite the shaft, showed a width of 12 ft. and averaged $35 a ton in gold across a drift width of 9 ft. for a length of 200 ft. High-grading activities on this level, said to be the best opened in the mine to date, are being carefully guarded against as the result of striking the high-grade stringer.

No. 2 shaft has now reached a depth of 2,200 ft. A crosscut to the vein at this depth last week struck the downward extension of No. 2 vein. On the 1,600 level, developments on this vein have shown its extension from boundary to boundary of the property, about 2,000 ft. in all.

Adverse rumors about Kirkland Lake mines notwithstanding, Lake Shore is continuing its program of expansion. A new tube mill has just been installed. Delays in delivery of structural steel for the new mill buildings have held up construction work. The plant will be operating at its increased capacity of 2,000 tons early in 1930, instead of at the end of this year, as originally planned. About 1,400 tons is being handled at present.

Dome Using Three Drills in Exploring Greenstone Area

DOME MINES, at Porcupine, Ont., is now operating three diamond drills underground in exploration of the greenstone area lying north of the sedimentary trough from which the bulk of its output has come. In addition, drifting and crosscutting in this area are under way between the No. 9 and 23 levels. The sedimentary orebodies were definitely proved to bottom at the No. 18 level, and the life of the property will therefore depend on opening up large reserves in the greenstone area.

At present, the sedimentary area is furnishing about 60 per cent of the tonnage and 70 per cent of the value of Dome's production, which is averaging about 1,500 tons daily and $300,000 monthly. To date, about two years' reserves have been opened up in the greenstone area, but this is of definitely lower grade than the average. The orebodies in this area are also smaller.

Directors Inspect Deep Levels at Wright-Hargreaves

Directors of Wright-Hargreaves Mines, who recently visited the property at Kirkland Lake, Ont., after their return to Buffalo expressed satisfaction with results of development work at the mine, particularly at the 2,125 and 2,250 levels. New discoveries on the 800 level, reported about two months ago, are not comparable in importance with the results obtained at depth. Profits for 1929 are likely to be about the same as in 1928, since the mill has been handling higher-grade ore, although tonnage is only about 470 tons daily, as compared with 700 tons daily most of last year.

Report New Magma Strike on 2,250 Level

On the 2,250 level, southwest of No. 5 shaft, Magma Copper is reported to have struck an upward extension of the orebody opened on the 2,550 level of its mine at Superior, Ariz. The *Wall Street Journal* states that the orebody has been opened at two points, 150 ft. apart, and that crosscuts have showed 26 and 31 ft. of ore, respectively. Average grade is about 4 per cent copper, with some silver and gold. This orebody has been opened for 700 ft. on the 2,550 level, and shows an average width of 23 ft. with an average copper content of 3.6 per cent.

Fields Wins Again in Tri-State Garden Contest

Ben Fields, of the Oklahoma-Woodchuck mine of Interstate Zinc & Lead, for the second year in succession has won first prize of $50 in the annual flower garden contest conducted under the supervision of the accident-prevention department of the Tri-State Zinc and Lead Ore Producers' Association. J. J. Thomas, of Evans-Wallower Lead, was awarded second prize of $35. Third prize went to Elmer Isern, of the Blue Goose mine of Commerce Mining & Royaty; fourth, to Fred Carpenter, of Consolidated Lead & Zinc; fifth, to J. L. Nelson, of the Discard mine of Century Zinc, and sixth, to W. L. Kepner, of Rialto Mining.

White Caps Cuts High Grade

Reports of high-grade ore on the 1,100 level of the White Caps mine, at Manhattan, Nev., have been confirmed by J. G. Kirchen, general manager of the company. This ore carries quicksilver and gold. The White Caps has had a curious career, having produced antimony and arsenic at various times in the past.

United Eastern Wins Suit

United Eastern Mining has been awarded $20,000 damages by the jury in the suit brought against Tom Reed in the superior court, in Mohave County, Ariz. The amount sued for was a little over $70,000.

The point at issue was whether or not the Tom Reed company had mined ore from the Big Jim vein, belonging to the United Eastern, or from the Side Line vein awarded the Tom Reed in a former suit.

More Tri-State Plants Adopting Flotation

FIRM demand for flotation concentrates in the Tri-State district is beginning to influence mill construction in the district. For several months demand for flotation concentrates has been increasing. At present it is estimated at close to 5,000 tons a week, while output is only about 3,500 tons.

The John L mill, being built by F. W. Evans, is constructed so that the orthodox rougher and cleaner jigs can be eliminated and the entire product of the mine cleaned over flotation machines. The new mill will contain three Butchart flotation machines and one ball mill, but room has been provided for doubling this equipment should the demand for float ore continue sufficiently strong to narrow the $3 spread now existing between the price of coarse and flotation concentrates. Missouri-Kansas Zinc Corporation, at its Waco properties, is also arranging to increase its flotation output at the expense of coarse output.

For a few years following the adoption of flotation in the district, these concentrates were not considered to be worth treatment. None of the 45,000-ton stock of zinc concentrates in the field is flotation concentrate now, however.

McIntyre Completes Erection of New 100-Ton Test Mill

CONSTRUCTION of the new 100-ton test mill, which will operate with the new process for gold-ore treatment evolved by James J. Denny, mill superintendent, has been completed by McIntyre Porcupine Mines at its property in the Porcupine district, northern Ontario. Laboratory tests confirmed Mr. Denny's theories, *E.&M.J.'s* correspondent has been informed, and their commercial possibilities should be thoroughly tested in the new plant. Details have not been announced, but a complete revolution in milling practice at Porcupine is predicted if the process proves successful.

Run-of-mine ore from the McIntyre property will be treated for six months. Decision on construction of an entirely new milling plant, to supersede the present 1,500-ton unit, will rest until then.

Complete Buildings at Shenandoah-Dives

Construction of mill buildings and the boarding house of Shenandoah-Dives Mining, in the Silverton district of Colorado, has been completed, and machinery is now being installed in the mill. Construction of the cable tramway from the Mayflower mine to the mill is practically complete, and installation of the new air compressor at the mine is scheduled to be finished about Oct. 20. About 150 men are now employed by the company. Operations on the basis of 300 tons daily will probably start about Nov. 10.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Huronian Belt to Reorganize, With Complete Control by Canadian Syndicate

TORONTO, ONT., Oct. 12, 1929.—An announcement has just been made that all interests of the Huronian Belt Company, a London organization, have been taken over by a syndicate of Toronto men, headed by R. Home Smith, who will be president of a new company to be formed, and A. Dorfman, who will be managing director. Huronian Belt has for years been a controlling factor in the Vipond mine, at Porcupine, Ont., the Keeley mine, of South Lorrain, and the Pioneer Mining Corporation, which is opening up the Minto property in Michipicoten. The Keeley and Vipond will continue their independent status. They are, however, associated wth Pioneer and Huronian Belt in various outside properties, all of these companies having contributed to the general fund to be expended in exploration work. Apparently the English directors have decided to retire from the Canadian mining field and Huronian Belt will be taken over by a Canadian company. Details of the financing have not yet been announced. During the last year or more Huronian Belt has fallen on hard times. The Canadian Lorrain property was not a success and Pioneer will probably need further financing in order to carry on.

THE SEARCH for the MacAlpine party has now entered its fifth week, and those in charge of the organization have given up hope of being able to carry on further work until the completion of the freeze-up, which will probably be ten days or two weeks. The situation has undoubtedly become more serious, although those most familiar with arctic conditions consider that the party of eight men have excellent chances of coming through. Within the last two weeks the various planes operating in rescue work have covered practically all of the proposed itinerary of the MacAlpine party between the Coppermine River and Baker's Lake.

C. ("Punch") Dickens made what was probably the most spectacular trip in the history of arctic flying and in his solo rescue flights flew approximately 5,000 miles and covered a large area of country, including Coronation Gulf, Fort Reliance, Beechy Lake, and Bathurst Inlet. Permanent rescue bases have now been established at Stony Rapids and at Baker Lake, with plenty of provisions and gas. Skis for all planes engaged in the rescue work have also been sent in and complete equipment for winter flying in the arctic. Further operations, however, will have to await the formation of ice of sufficient strength and a fall of snow sufficient to allow the planes to make safe landings.

At Central Manitoba Mines the mill is treating approximately 150 tons of $8 ore daily, and production is running $35,000 to $40,000 per month, which is sufficient to yield a small margin of profit after all charges. At the Tene Six property approximately 18,000 tons of $11 ore has been developed. Arrangements are being made to transport this ore to the mill, which is some distance away. The company has purchased a diamond drill to explore the main Kitchener vein at greater depth. The future of the property would appear to lie in development of additional oreshoots below the 500 level.

Zinc Institute's Tariff Stand Endorsed by Tri-State

ZINC operators of the Tri-State district passed a resolution backing the efforts of the American Zinc Institute to broaden the scope of the present tariff schedule on zinc to include zinc ores of less than 10 per cent metallic content, at the sixth annual meeting of the Tri-State Zinc and Lead Ore Producers' Association, held on Oct. 5. The American Zinc Institute and the Tri-State producers fear that unless such an extension is made to the tariff act a proposed project for the mining of low-grade ore in Canada, just across the international line, and shipping it for smelting across the line into the United States, duty free, will materialize. This would reduce the consumption of domestic concentrates by an amount equal to 700 tons of Tri-State concentrate weekly.

Fifteen directors were elected at the meeting as follows: F. N. Bendelari, Consolidated Lead & Zinc Company; Frank Childress, Skelton Lead & Zinc; S. H. Davis, Century Zinc; C. F. Dike, Interstate Zinc & Lead; P. W. George, Federal Mining & Smelting; A. M. Gaines, New Chicago Mines; W. T. Landrum, Cortez-King Brand; T. F. Lennan, Quapaw Mining; Charles A. Neal, Roberts Milling; C. W. Nicolson, Canam Metals; M. F. Owens, Black Eagle Mining; George W. Potter, Eagle-Picher Lead; George Provine, Tulsa Lead & Zinc; John Robinson, Commerce Mining & Royalty; and F. C. Wallower, Evans-Wallower Lead.

Liberty Montana Shipping Ore

One of the largest cars of concentrates ever shipped to the Anaconda smelter was sent recently by Liberty Montana Mines, operating the Mammouth group, near Cardwell, Mont. According to F. R. Springer, managing director, the car contained 80 tons, returning $184 per ton. Mining at the property is done entirely through a tunnel, and mining cost is said to be $2.10 per ton. All operations have been completely electrified. The company has recently installed a double-drum Sullivan hoist.

Mexico City Letter

BY W. L. VAIL
Special Correspondent

Passage of Labor Law, Now Almost Certain, Retards New Mining Ventures

MEXICO CITY, Oct. 12, 1929.—A general review of the mining situation in Mexico at present shows a rather gloomy outlook for the immediate future. A few mines where new orebodies have been discovered stand out in sharp contrast, but these are few indeed. The present uncertain attitude on the part of mine operators is undoubtedly a result of the knowledge that the proposed labor law, under debate in Congress, will probably pass. Anticipating the worst, many companies have begun a policy of "readjustment" to avoid operating under what they consider the oppressive clauses of the new law. This policy is general and is being put in force over a wide area. Sometimes one reason is advanced for cutting down labor forces, sometimes another, but the fact remains that thousands of men will be thrown out of employment before Congress passes the proposed law.

AS A RULE, mines are restricting development work and limiting operations to extraction of known ore reserves. Several projects for opening up old properties or for attempting the development of new finds are at a standstill, as the promoters feel that they should know the conditions under which they will have to operate before sinking capital into these ventures. Whether the new law will cause as much trouble, when put into operation, as its opponents claim it will is open to question, but the propagandists seem to have been successful in convincing mine operators that the proposed measure will hamper operations seriously.

The federal government is co-operating with the several states in the construction of new roads, and in some instances large mining companies are contributing funds. Important projects under way include a new road from Chihuahua to Batopilas and through the Tahumara country to western Chihuahua; one from Tepehuanes into Guanacevi and through to Durango; and one from the capital of Oaxaca to the isthmus of Yucatan.

West End Renews Leases

H. D. Budelman, general manager of West End Consolidated, announces that leases on the property at Tonopah, Nev., will be renewed. Some lessees claim that a considerable tonnage of ore remains in the old workings and that possibilities of new finds still remain. Old leases had been canceled on Oct. 1.

MARKET AND FINANCIAL NEWS

October Dividend Payments Exceed Total for Same Month Last Year

DIVIDEND disbursements to stockholders of mining and metal companies during October totaled $21,761,386, against $18,219,518 in the same month last year. The monthly totals for the current year have been consistently greater than those of 1928 and reflect, to a large extent, the general improvement which has taken place in the marketing of metals. All of the major non-ferrous metals—copper, lead, and zinc—have been selling on a higher level, and with the exception of zinc the outlook is certainly most encouraging from the producers' point of view. With copper at 17.775c. a pound, f.o.b. refinery, or higher, for eight consecutive months, that the copper shares have contributed heavily to the gain in returns to stockholders is but natural.

Dividends paid out by mining and metal companies, by months, for the current year, with comparisons, follow:

	1929	1928
January	$25,603,109	$20,486,560
February	21,678,018	17,797,953
March	38,852,438	32,299,402
April	26,646,607	18,256,890
May	29,830,215	17,359,998
June	47,496,806	33,828,275
July	30,572,926	21,230,143
August	34,060,240	19,866,629
September	46,327,048	34,481,266
October	21,761,386	18,219,518
Total	$322,828,793	$233,826,634

Total payments of dividends to stockholders in the first ten months of 1929 amounted to $322,828,793, a gain of 37 per cent compared with the corresponding period last year. The outlook for the remainder of the year is regarded as satisfactory, and that the disbursements for the full twelve-month period will show an even greater increase when compared with last year is altogether likely.

The annual per cent yield of a dollar invested in representative mining companies remains comparatively high, notwithstanding the appreciation in quotations for shares which has occurred since the first of the year.

Kennecott Copper paid out the largest sum during October, dividend disbursements by that company totaling $11,715,154, or more than half of the total for all companies listed in this month's tabulation. Disbursements by Greene Cananea amounted to $1,000,000, a gain of 100 per cent over the total paid out in October of last year.

ALASKA JUNEAU GOLD MINING COMPANY reports for the nine months ended Sept. 30, 1929, a surplus of $831,150 after interest and Ebner Mine development charges, comparing with $781,400 in same period of previous year. Gross income for the nine months ended Sept. 30 was $2,556,000, against $2,493,500 in corresponding period last year, and $1,760,000 in the like period in 1927.

E. & M. J. Compilation of Mining Dividends and Yields for October, 1929

Companies in United States	Situation	Per Share	Total Disbursements	Annual Per Cent Yield
American Zinc, Lead & Smelting, pfd	Ill., Tenn. and Wis.	$1.50 Q	$144,840	....
Bethlehem Steel Corp., pfd	U. S.	1.75 Q	1,749,151	5.6
Bunker Hill & Sullivan, s, l	Idaho	0.75 MX	234,250	6.2j
Consolidated Lead & Zinc	Kan., Okla.	0.25 Q	50,000	10.0
Copper Range, c	Mich.	0.50 Q	197,347	9.0
Cresson Consolidated, g	Colo.	0.02 Q	24,400	16.0
Eagle-Picher Lead	Mo., Okla.	0.20 Q	200,000	5.0
Eagle-Picher Lead, pfd	Mo., Okla.	1.50 Q	12,769	5.8j
Inspiration Consolidated, c	Ariz.	1.00 Q	1,181,967	9.0j
Kennecott Copper	Various	1.25 Q	11,715,154	6.0j
Magma Copper, c, s	Ariz.	1.25 Q	510,193	7.0j
Newmont Mining, h	Various	1.00 Q	452,760	1.8
Phelps Dodge, c	Various	0.75 Q	1,500,000	4.7
Silver King Coalition, s, l, z	Utah	0.25 Q	305,116	8.3j
Sloss-Sheffield Steel & Iron, pfd	Ala.	1.50 Q	40,247	8.0j
Tonopah Mining, s	Nev.	0.075 SA	75,000	6.0
U. S. Smelting, Refining & Mining	Various	0.875 Q	306,350	7.2j
U. S. Smelting, Refining & Mining, pfd	Various	0.875 Q	425,557	6.7j
Companies in Other Countries				
Dome Mines, g	Ontario	0.25 Q	238,333	11.0j
Greene Cananea Copper	Sonora	2.00 Q	1,000,000	4.7j
Hollinger Consolidated Gold	Ont.	0.05 M	246,000	10.9j
Howe Sound, s,c,l,z	B. C., Mex.	1.00 Q	744,057	6.6j
Lucky Tiger-Combination, g,s	Sonora	0.025 M	17,895	....
Nipissing, s	Ont.	0.075 Q	90,000	14.0j
Premier Gold, s, g	B. C.	0.06 Q	300,000	13.7j
Total			$21,761,386	

s, silver; l, lead; z, zinc; c, copper; g, gold; n, nickel, h, holding; Q, quarterly; M, monthly; MX, 25c. monthly and 50c. extra; SA, semi-annually; j, based on dividends for last twelve months.

London Financial News

G. H. GREEN
Special London Correspondent

LONDON, Oct. 1, 1929.—For some time the Huelva Copper & Sulphur Mines, in Spain, has been gradually extending its sphere of operations. On the Cueva de la Mora property, to which mining was mostly confined last year, the estimated ore reserves were only 47,000 tons, or hardly six months' supply to the plant. Following on the acquisition in 1928 of a large interest in the iron-ore proposition of the Mines de Dielette, near Cherbourg, France, the Huelva is now planning to enter the manganese field. With this object in view, it is acquiring a controlling interest in the Manganese Corporation, a concern with a capital of £1,000,000 in £1 ordinary shares, of which 842,000 have been issued. This company owns a property a few miles north of Postmasburg, to the north of the Cape Province of South Africa, about 127 miles from Kimberley. The deposit is described as probably one of the largest of high-grade manganese ore in existence, and it can be cheaply worked as an opencast operation. Full operations are expected to be in progress about the middle of next year, and from the work already done, the owners are said to have made contracts for delivery in 1930 of fairly large quantities. The Huelva, which is in a strong financial position, is making proposals to increase its capital from £422,100 to £1,005,000 to finance the undertaking.

When the Sabioncello interests acquired control of the Alianza Nitrate Company, a number of shareholders in the latter company were not included in the transaction, and they are naturally still interested in the progress of the group. When, therefore, it was announced that Sr. Sabioncello had also bought a controlling interest in the Pan de Azucar at 48s. per share, inquiries were made as to how the Alianza minority shareholders' interests were affected. The Alianza held 65,250 Pan de Azucar shares at cost, £161,528, or about 49s. 6d. per share, which compares with 30s. at the date of the last accounts. The policy of expansion may be sound enough, and the minority shareholders may have been wrong in their judgment when they refused the first offer, but, in the opinion of some of those interested, the high price paid for the Pan de Azucar shares by the controlling group calls for explanation.

NICKEL EXPORTS FROM CANADA, all grades, during September amounted to 7,183,000 lb., valued at $1,865,430.

Zinc Outlook in Europe Somewhat Obscure

INTERNATIONAL METAL SERVICE, LTD., LONDON

Oct. 1, 1929.—The course of affairs in the zinc industry has indeed been disappointing throughout September. Those especially concerned had hoped that the European cartel would decree some further curtailment of output at its meeting in mid-month, but unfortunately this hope was not fulfilled, and, as the next meeting is not to be held until November, nothing can be done this year to reduce output to such a level as will bring about an improvement in the statistical position of the metal.

There are, of course, two entirely opposite ways of looking at this decision to do nothing. One view is that European producers are convinced that output is now at a level which is no more than the normal consumptive demand, and the second is that owing to the difficulties of getting smelters to curtail production, even to the extent already agreed upon, the only thing to do is to leave the market to its own devices and wait until either consumptive demand improves to the desired extent or the price falls to a level which will enforce curtailment if only by reason of its unprofitableness.

The chief hopes of any sustained increase in consumption appear to lie in the very much overdue buying of galvanized sheets by India. So far there has been a small improvement in this direction, but the tonnage is by no means sufficient to justify its being called a buying wave. All that can be said is that stocks in India are known to be low. The Continental rolling trade is still in rather poor condition, and, with the approach of winter and the consequent slowing down of building activity, it hardly seems possible to look for much improvement in this direction for the next month or so. Zinc is a metal which in the past has witnessed sudden and unexpected changes in sentiment and it has never been safe to take a long view of the market.

We have spoken of the difficulties in the way of curtailment of output. In addition to the question of complications caused by the gradually increasing output of electrolytic zinc, there is the problem caused by the fact that the Silesian smelters have hitherto found compensation for decreased profits on the metal in the good market for sulphuric acid, and are naturally loath to lose this. The August figures of European production have been available too long to warrant reproduction here, but neither Poland nor Germany shows any falling away as compared with July. In most cases the figures are above the generally understood basis.

The fact that the mines are finding it unprofitable to produce ore with metal at its present price may help to bring about some check on output, and there are rumors that certain mines are seriously contemplating closing down until better times come round.

Of one thing we are certain: the present apparent consumption of zinc in Europe is not a true reflex of the actual power of absorption. Everybody overstocked and overbought in the early months of the year, and even now the whole of the accumulations have been barely worked off. But an end must come, even to the present seemingly interminable period of anxiety, and with the resumption of buying on a normal scale will come a better market for zinc.

World stocks of slab zinc on Oct. 1 are estimated as follows:

	Metric Tons
United States	48,400
Canada, including afloat	3,900
Germany-Poland	14,900
Belgium	9,700
France	1,700
Great Britain	3,700
Other Europe	2,500
Australia, including afloat	4,000
Far East	1,000
Elsewhere	2,100
Total	91,900

Total stocks on Oct. 1 show a gain over the figures for the preceding month of 5,500 metric tons.

Mexican Corporation, Ltd., Declares Interim Dividend

THE Mexican Corporation, Ltd., formed in London in 1919 to acquire mining properties in Mexico, has declared a maiden interim dividend of 1s. per share, payable Oct. 24. Development at the mines in which this company is interested continues to be satisfactory, according to a report to stockholders. Earnings at the Fresnillo mine, a silver property in Zacatecas, are at a good level, and the Teziutlan Copper Company is earning sufficient to pay its development and other expenses, leaving a surplus for reserve for developing a newly located orebody.

Chile Copper Earns $3.31 a Share in Six Months

CHILE Copper Company reports net profit of $14,643,563 for the six months ended June 30, 1929, after depreciation, interest, taxes, and other charges, equivalent to $3.31 a share earned on 4,415,499 shares of stock. This compares with $8,668,264, or $1.96 a share, in first half of 1928.

Consolidated income account for first half of the current year, compared with the corresponding period last year, follows:

	1929	1928
Total sales, pounds	141,912,628	126,672,677
Gross income	$26,401,648	$18,513,144
(a) Net profit	14,643,563	8,668,264

(a) After deducting all expenses and charges, including depreciation, amortized discount on bonds, accrued income, taxes and accrued bond interest.

CHROME ORE IMPORTED INTO THE UNITED STATES in July totaled 37,954 tons, valued at $316,993. Of the total tonnage imported, Greece shipped 3,116; Cuba, 5,565; British India, 4,385; Union of South Africa, 1,000, and Mozambique, 23,888 tons.

Total Copper Stocks Show Moderate Increase

STOCKS of blister and refined copper in North and South America increased to the extent of 1,386 tons during September, bringing the total at the end of the month to 347,436 tons, according to the American Bureau of Metal Statistics. Stocks of refined declined from 104,372 tons on the last day of August to 94,751 tons on Sept. 30, owing largely to the strike which interrupted operations at the Chrome, N. J., refinery. The loss in refined stocks was more than made up by the increase in the supply of blister. The rate of production at the mines underwent little change during the month, being maintained at a point well under the peak of the year.

Refined Copper Production, Shipments, and Stocks—North and South America

	September 1929	Jan.-Sept. 1929
Production:		
Primary	127,605	1,296,740
Scrap	6,738	78,698
Total	134,343	1,375,438
Daily rate	4,478	5,038
Shipments:		
Exports	45,921	459,602
Domestic	98,043	886,551
Total	143,964	1,346,153
Stock, Aug. 31	94,751	.....

Summary of Copper Statistics in August and September

	August 1929	September 1929
Production:		
U. S. mines	78,885	78,669
Blister, No. America	104,523	104,595
Blister, So. America	30,971	30,801
Refined, No. and So. Am.	148,648	134,343
World, blister basis	174,329	.....
Stocks:		
No. and So. America—		
Blister and in process	241,678	252,685
Refined	104,372	94,751
Total	346,050	347,436
Great Britain, total	10,862	8,716
Havre	7,536	7,805

Distribution of United States Copper Production

	August	September
Porphyry mines	31,118	30,927
Lake mines	7,120	7,738
Vein mines	35,147	34,504
Custom ores	5,500	5,500
Total crude production	78,885	78,669
Daily rate	2,545	2,622
Imports in ore and matte	8,769	.....
Blister from scrap	3,889	.....
Smelter production	91,735	.....

Shipments of refined copper from North and South America for the first nine months of 1929 totaled 1,346,153 tons, against 1,218,783 tons in the same period last year.

COPPER SHIPPED BY BOAT out of the Michigan copper district in September totaled 10,418,000 lb. of refined metal. Of this amount, Calumet & Hecla Consolidated moved 7,868,000 lb.; Quincy shipped 126,000 lb.; and 2,424,000 was loaded at the Michigan smelter at Houghton, representing Copper Range, Mohawk, and Isle Royale metal. Shipments during the remainder of the season of navigation are expected to be higher.

The Market Report

Lead and Tin Sales Improve Slightly—Copper and Zinc Dull

New York, Oct. 16, 1929.—Dullness continues as the chief characteristic of the non-ferrous metal markets, though both lead and tin sold in somewhat larger volume than in the preceding week, the cheap offerings of tin stimulating business on Monday. Silver prices have fluctuated at slightly higher levels than a week ago. Copper, lead, and zinc seem well stabilized at current quotations in the domestic market, though London quotations weakened somewhat. The minor metals continue substantially unchanged.

Daily Prices of Metals

Oct.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
10	17.775	43.25	6.90	6.70	6.80
11	17.775	42.875	6.90	6.70	6.80
12	Holiday	.....	....	....	....
14	17.775	42.25	6.90	6.70	6.80
15	17.775	42.25	6.90	6.70	6.80
16	17.775	42.125	6.90	6.70	6.80
	17.775	42.550	6.900	6.700	6.800

Average prices for calendar week ending Oct. 12, 1929, are: Copper, 17.775c.; Straits tin, 43.325c.; New York lead, 6.900c.; St. Louis lead, 6.700c.; zinc, 6.800c.; and silver, 49.775c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East are 1@1¼c., depending upon purity, above St. Louis prices for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Oct.	Copper		Electrolytic	Tin		Lead		Zinc	
	Standard								
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
10	73 9/16	74 1/8	84 1/2	195 3/8	200	23 5/16	23 7/16	23 3/8	23 1/2
11	73 7/8	74 1/2	84 1/4	194 1/2	198 1/2	23 3/8	23 1/2	23 3/8	23 13/16
14	73 3/4	74 1/8	84 1/2	189 3/4	194 1/2	23 3/8	23 7/16	23 1/4	23 3/4
15	73 3/8	73 5/8	84 1/4	191 1/2	195 3/4	23 1/4	23 3/8	22 3/4	23 3/16
16	72 7/8	73 1/4	84 1/4	189 3/4	194 1/4	23	23 5/16	22 13/16	23 5/16

Prices for lead and zinc are the official closing prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Silver, Gold, and Sterling Exchange

Oct.	Sterling Exchange "Checks"	Silver		Gold London	Oct.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
10	$4.86	50	23 1/16	84s11½d	14	$4.86	49 3/4	23 1/16	84s11½d
11	4.85 7/8	49 5/8	22 15/16	84s11½d	15	4.86 1/4	50 1/8	23 1/16	84s10d
12	Holiday	....	23 1/8	.....	16	4.86 1/4	49 7/8	23 1/8	84s10d

Average: Silver, 49.875c.; Sterling Exchange, $4.86075

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Copper Continues Dull

No change has occurred in the complexion of the copper market in the last week so far as price and volume of sales go, the quotation being uniformly 18c. for Connecticut deliveries and 18⅛c. in the Middle West, and the domestic business continuing to approximate a thousand tons a day. This means that producers are accumulating unsold copper, but they expect to wind up the year with their books in good condition, as another buying movement for November and December shipment seems fairly certain to come. One estimate places the tonnage that remains to be bought for domestic and foreign shipment before the end of the year at 150,000 tons, but such an estimate is little more than an intelligent guess, for no one knows how much overbuying there was in the early September rush.

Custom smelters have again done the lion's share of the business. Most of the demand has been split between prompt and November shipment. No interest has been shown in December, though an occasional order for January has been booked.

The foreign market continues disappointing, with sales so far this month well below normal. The price continues at 18.30c., c.i.f. usual European ports.

Zinc Still at 6.80c.

Through consumers continue to hold off, and foreign prices continue to decline, producers still present an unbroken front in holding their quotations at 6.80c., feeling that buying cannot be much longer postponed. Recent records fail to show any time when undelivered sales were as low as they are now, and most of the buying is for prompt shipment. The decline in London, which has brought zinc prices to approximately import parity even with the 1¾c. duty, is not taken seriously by domestic sellers except for its sentimental effect. A much greater spread would be necessary before there would be much likelihood of foreign zinc being imported.

Good Sales in Lead

Compared with the other non-ferrous metals, the lead market gave a fairly good account of itself, the sales total for the week being in excess of 5,000 tons. Prices ruled firm, all of the business passing on the unchanged basis of 6.90c., New York, and 6.70c., St. Louis. Demand was mostly for prompt and early November shipment. The September statistics exerted a favorable influence upon the market. Corroders were very much in evidence in taking metal, and it is estimated that fully half of the lead sold during the week was purchased by these factors. Cable and battery makers also took on fair amounts. Lead is moving into consumption at a good rate, and from present indications October shipments should attain a total of 60,000 tons or more, so that stocks at the end of the current month may show another decline.

Stocks of refined lead, including anti-

monial, in the United States and Mexico, showed a drop during September of 3,985 tons, the figure on the last day of the month being 72,590 tons, according to the A.B.M.S. Production of crude in the two countries totaled 78,684 tons, against 79,239 tons in August. Production of refined, including antimonial, was 80,843 tons in September, against 87,220 tons in the preceding month.

Domestic lead shipments to consumers in September amounted to 68,916 tons, which compares with 66,085 tons in the corresponding month last year.

Tin Prices Weak

Prices for tin again moved downward, the decline for the week amounting to 1½c. a pound in the domestic market. Some good buying on the part of consumers developed at the lower levels, sales on Monday alone being between 700 and 800 tons. The weakness here was in sympathy with London, where support by the tin group was not sufficient to stem the downward course of the market. Despite the decline in prices, sentiment remains decidedly mixed, consumers taking the stand that ample tin is being produced to meet all ordinary demands.

Silver Low and Inactive

During the last week the silver market has been quiet and irregular, prices fluctuating between 49⅝ and 50⅛c. India has been a moderate buyer at the lower level and China has operated both ways. The tendency is still uncertain.

Mexican Dollars (old Mexican pesos): Oct. 10th, 37⅛c.; 11th, 36¾c.; 12th, holiday; 14th, 36⅞c.; 15th, 37¼c.; 16th, 37c.

Foreign Exchange

No important changes occurred in the leading European exchanges during the week. Closing cable quotations on Tuesday, Oct. 15, were as follows: Francs, 3.92⅛c.; lire, 5.23⅝c.; and marks, 23.86c. Canadian dollars, ⅞ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York: Chinese brands 8⅛c. per lb. for spot and future shipments. Inquiry has improved somewhat and prices have steadied. Cookson's "C" grade, spot, 14c.

BISMUTH—Per lb., New York, in ton lots, $1.70. Smaller lots, $1.80 and up.

CADMIUM — Per lb., New York: 80@90c. Demand for cadmium keeps up surprisingly well, despite slackening in automotive industry.

IRIDIUM — Per oz., $220@$230 for 98@99 per cent sponge and powder.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $36@$38. Small lots bring up to $48. Nominal.

PLATINUM—Official price quoted by the leading interest on small orders for refined metal is $65 per oz. Transactions between dealers and refineries in the outside market are reported at several dollars less.

QUICKSILVER — Per 76-lb. flask, $124@$125. Small lots command the usual premiums.

Prices of Chromium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Titanium, Tungsten, Vanadium, and Zirconium are unchanged from the issue of Oct. 5.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $15.25@$15.50 for future shipment. Demand moderate, but with no pressure to sell apparent in the China market, prices are fairly steady. Bolivian scheelite, $15.50@$15.75 Nov.-Dec. shipment. Western scheelite, $16.50 for Jan. shipment.

Antimony, Chrome, Iron, Manganese, Tantalum, Titanium, Vanadium, and Zircon ores are unchanged from quotations in the Oct. 5 issue.

Platteville, Wis., Oct. 12, 1929

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$46.75
Lead Ore	
Lead, basis 80 per cent	$90.00

Shipments for the week: Blende, 419 tons; lead, none. Shipments for the year: Blende, 26,672; lead, 1,660 tons. Shipments for the week to separating plants, 942 tons blende.

Tri-State Prices on Flotation Concentrate in Dispute

Joplin, Mo., Oct. 12, 1929.

Blende	Per Ton
High	$46.90
Premium blende, basis 60%	44.00
Prime Western, basis 60%	$43.00@ 44.00
Table concentrate, 60%	41.00@ 42.00
Flotation concentrate, 60%	40.00@ 41.00
Average settling price	44.75
Galena	
High	$88.80
Basis 80% lead	87.50
Average settling price	87.40

Shipments for the week: Blende, 11,995; lead, 1,692 tons. Value, all ores the week, $683,870.

The Allen Sales Agency this week presented its first aggressive move since it began functioning last February. Flotation concentrates, which sold three months ago on $39 basis, already advanced by sharp demand to $41 basis, were chosen as the medium of attack. Mainly to shift demand to coarse concentrates, the agency this week advanced the price of table and flotation concentrates to $42.50 basis. This was dropping a gauntlet for a fight, and the fight was waged from Thursday to the week end, with both sides unyielding. Sellers would accept only $42.50 basis. Buyers would offer only $41 basis. The result was largely increased sales of coarse concentrates, selling at the unchanged price of $44 basis.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Oct. 5 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) Per lb., 4c. Good contract business and prices holding firm.

SODIUM NITRATE — Per 100 lb., $2.10 for October delivery.

Antimony Oxide, Calcium Molybdate, Copper Sulphate, Sodium Sulphate, and Zinc Oxide are unchanged from prices in the Oct. 5 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105. Spiegeleisen, 19@21 per cent, $34 f.o.b. furnace on carload business.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.45@$1.50, f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferrovanadium, Nickel Silver, and Yellow (Muntz) Metal are unchanged from prices in the Oct. 5 issue.

Rolled Metals

Copper, lead, zinc, Monel metal, and nickel sheets, and copper wire, are unchanged from prices in the Oct. 5 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Oct. 5.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces, Bessemer, $19; basic, $18.50; No. 2 foundry, $18.50.

STEEL—Base prices per gross ton Pittsburgh, billets and slabs, $35; plates, structural shapes, and soft steel bars, per 100 lb., $1.95.

COKE—Per gross ton, Connellsville furnace, $2.65@$2.75. Connellsville foundry, $3.75@$4.85. Byproduct coke, Ohio and Kentucky (Connellsville basis) $6.50; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ended October 12, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda Copper	New York	119¼	113¾	116¼	Oc. 11 No. 18 Q	1.75
Andes Copper	New York	53¾	50	52¾	Oc. 11 No 11 Q	0.75
Arizona Com	Boston	1¼	1¼	1¼	Jl. 16 Jl. 31 SA	0.25
Calumet & Ariz	New York	125	120½	123¾	Se. 6 Se. 23 Q	2.50
Claumet & Hecla	New York	41	40½	40½	Au. 31 Se. 30 Q	1.00
Cerro de Pasco	New York	93½	91	92	Oc. 10 No. 1 Q	1.50
Con. Coppermines	N. Y. Curb	9	8⅜	8⅜		
Copper Range	Boston	22	21½	22	Se. 14 Oc. 15 Q	0.50
East Butte	Boston	2½	1⅜	2	Dec., 1919	0.50
Granby Con	New York	87¾	84½	86	Oc. 18 No. 1 Q	2.00
Greene Cananea	New York	176½	176½	176½	Se. 12 Oc. 7 Q	2.00
Howe Sound	New York	61¼	59	60½	Se. 30 Oc. 15 Q	1.00
Hudson Bay	N. Y. Curb	17⅜	16⅛	16⅛		
Inspiration	New York	44	41	42⅜	Se. 9 Oc. 7 Q	1.00
Isle Royale	Boston	22¼	20⅜	21¼	Au. 31., Se. 30	0.50
Kennecott	New York	84⅛	80¼	82⅜	Au. 30, Oc. 1 Q	1.25
Magma Copper	New York	74	67½	72½	Se. 30, Oc. 15 Q	1.25
Mason Valley	N. Y. Curb	2	2	2		
Miami Copper	New York	43¼	40½	42⅞	No. 1, No. 15 Q	1.00
Mohawk	Boston	61	57½	61	Jl. 31, Se. 2 Q	2.00
Mother Lode	New York	2½	2⅜	2⅜	Je. 13, Je. 29	0.20
Nevada Con	New York	47½	42⅜	47⅜	Se. 18, Se. 30 Q	0.75
Noranda	N. Y. Curb	51	48⅜	49⅜		
Ohio Copper	N. Y. Curb	1⅜	1⅛	1⅛	Sept., 1926	0.03
Old Dominion	Boston	8¼	7⅜	8⅛	Dec., 1918	1.00
Phelphs Dodge	New York	64⅜	61½	62	Se. 4, Oc. 1 Q	0.75
Quincy	Boston	47½	40	46⅜	March, 1920	1.00
Roan Antelope	N. Y. Curb	43¾	41½	42½		
St. Mary's M. L.	Boston	38	37	37	Fe. 25, Mr. 12	2.00
Seneca Copper	New York	4⅜	4½	4⅜		
Shattuck Denn	N. Y. Crb	14⅜	12⅞	13⅛		
Sheritt-Gordon	Toronto	6.50	6.00	6.50		
Tenn. C. & C.	New York	18	17	18	Au. 31, Se. 16 Q	0.25
United Verde Ex.	N. Y. Curb	15½	15	15½	Oc. 2, No. 1 Q	1.00
Utah Copper	New York			325	Se. 18, Se. 30 Q.	4.00
Waite-Ack.-Mont.	Toronto	4.50	4.50	4.50		
Walker Mining	Salt Lake	6.00	5.75	6.00		
Wenden Copper	N. Y. Curb	1.12½	*87½	1.00		
LEAD, ZINC, SILVER						
Ahumada Lead	New York	1⅜	1⅛	1⅜		
Amer. Z. L. & S.	New York	19	17⅜	18½	May, 1917	1.00
A. Z. L. & S., pfd.	New York	90½	90½	90½	Se. 19, Oc. 1 Q	1.50
Bunker Hill & S.	N. Y. Curb	130	130	130	Se. 27, Oc. 5 MX	0.75
Butte Cop. & Zn.	New York	4	3⅜	3⅞		
Butte Cop. Con.	Boston Curb	*50	*37½	*43¾		
Butte & Sup.	New York	6⅜	6⅛	6⅜	Je. 14, Je. 29 Q	0.50
Callahan Zn-Ld.	New York	2	1⅜	1⅜	Dec., 1920	0.50
Chief Consol.	Salt Lake			2.75	Fe. 1, 1918 K	0.10
Consol. Ld. & Zn. "A"	St. Louis	10	9⅛	9⅛	Se. 20, Oc. 1 Q	0.25
Constitution	Spokane	*44	*42½	*42½		
Dayrock	Spokane	3.45	3.30	3.30	Je. 20, Je. 30	0.03
Dickens Consol	Spokane	*8½	*7⅞	*7⅞		
Eagle-Picher	Cincinnati	16½	15⅞	16	Se. 30, Oc. 15 Q	0.20
Eagle-Pich., pfd	Cincinnati			102	Se. 30, Oc. 15 Q	1.50
Erupcion	Boston Curb			*12	Jan. 1, 1928	0.07½
Eureak Bullion	Salt Lake	*85	*80	*85		
Evans-Wallower	N. Y. Curb	16⅞	16⅞	16⅞		
Evans-Wal., pfd.	N. Y. Curb			80	Je. 20, Jl. 1 Q	1.75
Federal M. & S.	New York			2.37	June, 1927	10.00
Fed. M. & S., pfd.	New York	98¼	98¼	98¼	Au. 23, Se. 16 Q	1.75
Gladstone	Spokane	*3¼	*3¼	*3¼		
Golconda	Spokane	*89¼	*81	*81	Je. 15, Jl. 1	0.02
Grandview	Spokane	*27¾	*25¼	*25¼		
Heela Mining	N. Y. Curb	16⅜	15⅝	16⅜	Au. 15, Se. 15 Q	0.25
Highland-Surprise	Spokane	*13¼	*13	*13		
Jack Waite	Spokane	*13	*11½	*11½		
Kootenay Florence	Spokane	*11¼	*11½	*11½		
Lucky Jim	Spokane	*13	*11½	*11½		
Lucky Tiger-C	Kansas City	†3.00	†2.87½		Oc. 10, Oc. 20 M	0.02½
Mexican Premier	Spokane	2.22	2.20	2.20		
National Lead	New York	190¼	178	185	Se. 13, Se. 30 Q	1.25
Natl. Lead, pfd. A	New York	139¼	139	139	Au. 30, Se. 14 Q	1.75
Natl. Lead, pfd. B	New York	116½	110	116	Oc. 18, No. 1 Q	1.50
N. J. Zinc, new	N. Y. Curb	84⅜	81	82½	Oc. 21, No. 9 Q	0.50
New Quincy	Salt Lake	1.80	1.45	1.75	Se. 20, Se. 30 Q	0.10
Noble Five	Spokane	*55	*52	*52		
North Lily	Salt Lake	5.25	4.65	5.20	Oc. 16, Oc. 23	0.25
Park Bingham	Salt Lake	7.77	7.77	7.77		
Park City Con.	Salt Lake	†1.75	†1.50			
Park Utah	New York	4½	4	4⅛	Dividends suspended	
Pend Oreille	Spokane	4.00	3.50	3.50		
Rico Argentine	Salt Lake	*25½	*25	*25½	No. 30, De. 15 Q	0.03
Ruth-Hope	Spokane	*34	*30	*30		
St. Joseph Lead	New York	71½	63½	70	Se. 10, Se. 20 QX	0.75
Sherman Lead	Spokane	*72	*70	*70		
Silver King Coa	Salt Lake	12.50	12.00	12.50	Se. 20, Oc. 1 Q	0.25
Silversmith	Spokane	*8¼	*7½	*7⅞	Oct., 1926	0.02
Sunshine Mining	Spokane	7.10	6.60	6.60	Se. 10, Se. 20 Q	0.05
Tamarack-Custer	Spokane	*63	*54	*54	Sept., 1924	0.25
Tintic Standard	Salt Lake	12.62½	12.50	12.62½	Se. 17, Se. 20 X	0.30
Tonopah Belmont	N. Y. Curb	*50	*50	*50	Oct., 1925	0.05
Treadwell-Yukon	Toronto	8.00	7.70	8.00		
United Zinc Smg.	N. Y. Curb			*68⅜		
Utah Apex	Boston	5¼	4	5	Oc. 15, No. 1	0.25
Utah Met.& Tun.	Boston	1.00	*90	*95	Dec., 1927	0.30
Whitewater	Spokane	*41	*35	*35		
Yellow Pine	Los Angeles			*8	Dec., 1925	0.04
GOLD						
Alaska Juneau	New York	8¼	7⅛	7⅛		
Barry-Hollinger	Toronto	*21	*19	*20		
Central Manitoba	Toronto	*28	*25	*26		
Cresson Consol	N. Y. Curb	*56¼	*50	*50	Se. 30, Oc. 10 Q	0.02
Dome Mines	New York	9	8⅜	8⅜	Se. 30, Oc. 21 Q	0.25
Golden Cycle	Col. Springs	†1.67½	†1.62½		Au. 31, Se. 10 Q	0.04
Hollinger	Toronto	5.95	5.30	5.95	Oc. 18, No. 4 FW	0.05
Homestake	New York	85	84½	84½	Oc. 19, Oc. 25 M	0.50
Kirkland Lake	Toronto	*68	*48	*67		
Lake Shore	Toronto	23.25	20.75	22.50	Se. 17, QX	0.40
McIntyre Porcupine	New York	14¾	14¼	14¼	Au. 1, Se. 2 Q	0.25
Portland	Col. Springs	†*11¼	†*8		April, 1927	0.02
Rand Mines	New York			35½	Au. 21, 29 A.s.	1.51
Siscoe	Toronto	*82	*76	*80		
Sylvanite	Toronto	*68	*60	*68		
Teck-Hughes	Toronto	6.00	5.55	6.00	Oc. 18, No. 1	0.15
Tom Reed	Los Angeles			*60	Dec., 1926	0.02
Unity Gold	N. Y. Curb	1.12½	*93¾	1.12½		
Vipond Consol	Toronto	*80	*62	*78	April, 1927	0.03
Wright-Hargreaves	Toronto	1.60	1.35	1.45	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb			35⅛		
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	15⅞	15	15⅞		
Castle-Trethewey	Toronto	*30½	*29⅜	*30		
Consol. Cortez	N. Y. Curb	*12½	*6½	*12½		
Dolores Esperanza	N. Y. Curb	1.32½	*43¾	*43¾	July, 1923	0.05
Keeley	Toronto	*50	*48	*48	Mr. 15, 1928	0.04
Mining Corp.	Toronto	3.95	3.60	3.95	My. 30, Je. 13	0.12½
Montana-Mines Corp.	Spokane	*50	*48½	48½		
N. Y. & Hond. Ros.	N. Y. Curb	16	15	15½	Oc. 16, Oc. 26 QX	0.50
Nipissing	N. Y. Curb	2⅛	2	2	Se. 26, Oc. 21 Q	0.07½
Premier Gold	N. Y. Curb	1¼	1⅛	1⅛	Se. 12, Oc. 3 Q	0.06
Tonopah Exten.	N. Y. Curb			*10	April, 1925	0.05
Tonopah Mining	N. Y. Curb	2⅜	2⅜	2⅜	Se. 30, Oc. 21	0.07½
United Eastern	N. Y. Curb	*25	*25	*25		
Yukon Gold	N. Y. Curb	*93¾	*56½	*56½	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	120¾	113¾	120½	Oc 18, No. 15 Q	1.50
Beth. Steel, pfd, 7%.	New York	125½	125½	125½	Se. 6, Oc. 1 Q	1.75
Cleveland-Cliffs	Cleveland	100	97	97½	Se. 5, Se. 15 Q	1.00
Colo. Fuel & Iron	New York	64¾	60¾	63		
Colo. F. & I., 1st pfd.	New York	126	126	126	Au. 10, Se. 26 Q	2.00
Great Northern Iron	New York	32½	29	31½	Dec. 15 K	2.00
Inland Steel	New York	101¾	99	100	Au. 15, Se. 1 Q	1.87½
Republic I. & S.	New York	133¼	123	130½	My. 11, Je. 1 Q	1.00
Republic I. & S. pfd.	New York	111	110½	111	Je. 12, Jl. 1 Q	1.75
Sloss-Sheffield S. & I.	New York	50	50	50	Mr. 11, Mr. 20 Q	1.50
Sloss-Sheff. S.&I., pfd.	New York	68	68	68	Se. 20, Oc. 1 Q	1.50
U. S. Steel	New York	234	215½	230½	Au. 29, Se. 28 Q	1.75
U. S. Steel, pfd.	New York	143½	142⅜	142½	Au. 5, Au. 30 Q	1.75
Virginia I. C. & C.	New York	20	20	20	Jan., 1924	1.50
Virginia I.C.&C., pfd.	New York	43	43	43	Jl. 16, 1928 SA	2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	440	390	430½		
Alum. Co. of Amer., pf.	N. Y. Curb	106½	106½	106½	Mr. 15, Ap. 1 Q	1.50
American Metal	New York	70½	67½	69½	Au. 21, Se. 1 Q	0.75
Amer. Metal, pfd., 6%	New York	127½	126½	126½	Au. 21, Se. 3 Q	1.50
Amer. Sm. & Ref.	New York	116½	109¾	114¾	Oc. 11, No. 1 Q	1.00
Amer. Sm. & Ref., pfd.	New York	135¾	135½	135½	No. 1, De. 2 Q	1.75
Ang. Ch. Nitrate	N. Y. Curb	37½	32⅜	32⅜		
Asbestos Corp.	Montreal	5½	4	4½	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal			17	De. 31, Ja. 15 Q	1.75
Consol. M. & S.	Montreal	385	380	380	Je. 29, Jl. 15 SA	X6.25
De Beers Consol	New York			21	Jl. 23, Jl. 26 Q	0.96
Federated Metals	N. Y. Curb	35¾	34¼	34½	Oc. 3, Oc. 11 Q	0.25
Freeport Texas	New York	45¾	42⅛	44⅛	Oc. 15, No. 1 Q	1.00
Int. Nickel Can.	New York	55½	52⅜	54¼	Au. 31, Se. 30 Q	0.25
Int. Nickel, pfd.	New York			120	Se. 28, No. 1 Q	1.75
Mayflower Assoc.	N. Y. Curb	100¾	94½	99		
Metal & Mining	N. Y. Curb	17⅜	16	17⅜	Se. 21, Oc. 1	0.30
Newmont	N. Y. Curb	223¾	209	218½	Se. 30, Oc. 15 Q	1.00
Patino M. & E.	New York	38⅜	37½	37⅝	Au. 31, Se. 28 A.s.	0.97
So. America G. & P.	N. Y. Curb	2½	2	2		
Texas Gulf Sulphur	New York	71½	67½	70½	Se. 2, Se. 16 Q	1.00
U. S. Sm. R. & M.	New York	50½	47	48½	Oc. 7, Oc. 15 Q	0.87½
U. S. Sm. R. & M., pfd	New York	55	53¾	54	Oc. 7, Oc. 15 Q	0.87½
Vanadium Corp.	New York	86¾	79	85	Au. 1, Au. 15 Q	0.75

Toronto Standard Stock Exchange, Toronto, courtesy the Arthur E. Moysey Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Standard Stock Exchange, Spokane, courtesy Pohlman Investment Company

*Cents per share. †Bid or asked. Q, Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I Initial. R, Respumption. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend. A.s., American shares.

LONDON QUOTATIONS—WEEK ENDED October 1, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	20/—	20/—	20/—		
Alaska Treadwell ($25)	60/—	60/—	60/—	Nov., 1926	4 p.c.
Aramayo Mines (25 frs.)	56/3	56/3	56/3	Aug., 1929	5 p.c.
Burma Corpn. (10 rupees)	18/1½	17/6	17/7½	July, 1929	9 annas*
Bwana M'Kubwa (5s)	30/9	25/—	26/3		
Camp Bird (2s)	2/7½	2/3	2/4½	April, 1928	16½ p.c.
El Oro (5s)	2/9	2/9	2/9	Nov., 1924	2½ p.c.*
Frontino & Bolivia (£1)	6/10½	6/10½	6/10½	Jan., 1929	3½ p.c. (e)
Mexican Corpn. (£1)	17/3	16/3	16/—	Oct., 1929	10 p.c.
Mexico Mines of El Oro (£1)	5/1½	3/1½	5/1½	Dec., 1926	3½ p.c.*
Mount Isa (£1)	37/—	34/4½	36/3		
N'Changa Copper Mining (£1)	70/—	47/6	52/6		
Oroville Dredging (4s)	1/9	1/9	1/9	Nov., 1928	31½ p.c.
Rhodesian Congo Border (£1)	198/1½	165/—	167/6		
St. John del Rey (£1)	17/7½	16/6	16/6	April, 1929	7½ p.c.
San Francisco Mines (10s)	36/3	35/1½	36/—	June, 1929	15 p.c.
Santa Gertrudis (£1)	11/6	9/10½	10/6	July, 1929	7½ p.c.
Selukwe (2s. 6d.)	6/9	5/3	5/9	April, 1917	6¾ p.c.
S. Amer. Copper (2s)	2/10½	2/6	2/9	Nov., 1917	75 p.c.
Tanganyika (£1)	58/9	53/9	55/7½	July, 1929	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	11,600	11,050	11,050	April, 1929	300 fr. (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian francs and free of taxation. e—on original £1 shares.